POWER

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Pointers to Success

PERHAPS one of the most convincing arguments in favor of education can be found in the large percentage of young men who are today filling the higher-up executive positions in all lines of business. While recently inspecting one of the largest central-station plants in New England, the writer was particularly impressed with the comparative youth of the executive personnel. Many of them were men from the ranks, who, by close observation and study, had fitted themselves for their present duties. Only three were college or university men with degrees. I asked the thirty-five year old superintendent of power, who has climbed the ladder by way of the boiler room, just how he had fitted himself for his position, and his reply is food for thought for many of the young fellows in the field today. He said:

"My heart and brain were in my work, and the best textbooks, papers and journals were my companions in most of my leisure time. I always solicited help in any problem from my fellow engineers, superiors and others who were able and willing to assist me. I had confidence in myself and never was content to remain at a standstill after I had made ready for the next step."

The secret of this man's success lay in the fact that he had made a decision early in his youth to have confidence in his ability to never stand still too long—to keep on climbing and to get help from the other fellows with which to boost himself up another rung on the ladder.

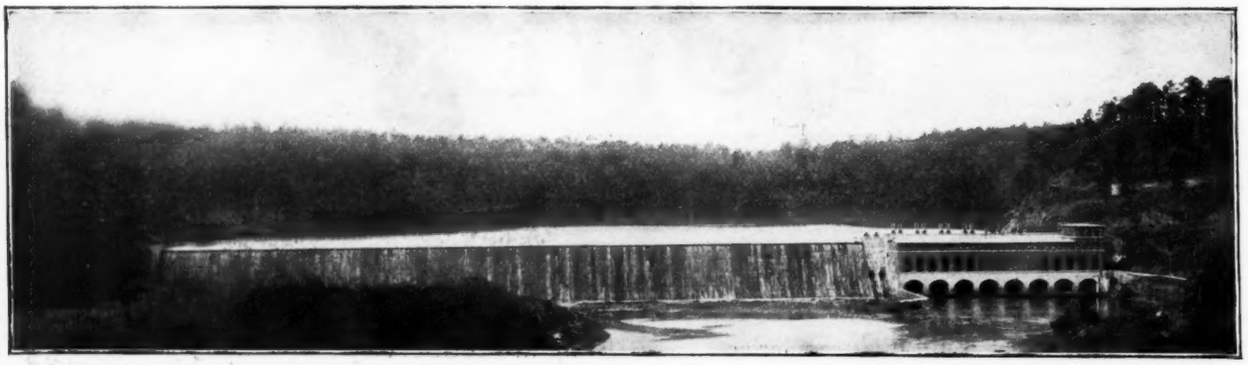
Look right about you among fellows you used to know. Some of them, no abler than you, are climbing, and what they are accomplishing you can accomplish. Studying alone—trying to teach oneself in spare time at home—is the hardest kind of work. Of course it is discouraging not to have assistance when you get stuck on some problem. Your studies can be lightened a great deal and made more interesting if you have the right kind of reading matter. The technical press is the workman's teacher, and some papers will even respond to appeals for help in understanding the principles of working problems.

Avail yourself of the privilege of laying your perplexities before some of the best men in the field, who will gladly help you through the pages devoted to plant problems. Often there are talks or lectures that you can attend, or perhaps there is an association of engineers to which you should belong and get some of the benefits of the discussions which take place. You will get some pointers at each meeting, and the personal contact with the local engineers is valuable. There are lots of problems to argue about, and this battle of wits will stimulate increased interest in your study of books and journals, for, when you get cornered in an argument, you will always look up the subject in the book or consult your trade journal, if you are a real engineer.

There are unlimited ways for you to train yourself for the bigger job if you are willing to sacrifice a portion of your time, energy and money. Nobody can push you ahead; your employer can open a path for you only when he is able to see increased value in your ability to handle the work. He may take a special sort of interest in you—but even this is of little help if he finds you are not training or assisting yourself. So it's up to you to make good. Many a man has been able to make himself so valuable that his services are always in demand, and this sort of man, you will always notice, is a close student of his calling.

Character, energy, brains, initiative and capacity for responsibility are the factors that make modern engineers command, instead of seek their positions. The envious attribute success to luck. Not every man can reach the top, for there are not enough places to go around. Some fellows soothe their minds with such thoughts, which are but lame excuses, for they are too lazy to study. They get just about so far and then plod along in a rut during their remaining years. The very sight of such men should stimulate a desire in you to avoid following in their path.

Contributed by C. H. Willey



Interconnected Power Systems of the South*

Hydro-electric systems of independent companies operating in five states are connected into one vast transportation system. These plants are mainly hydro-electric, but several steam stand-by plants are included. The United States Geological Survey has estimated the available power in the headwaters of the Appalachian Mountains at 2,800,000 hp., and the estimate for all the systems of the South is about 5,000,000 horsepower.

HYDRO-ELECTRIC power is a resource that will attract to a community a line of manufacturing that usually seeks cheap power as the prime requisite. The development of high-tension transmission systems has become common in many parts of the United States, but it was in the South that the logical and obvious thing was first done by interconnecting a number of systems with resultant advantages and economies. By this interconnecting of power plants the Southern States can boast a high-tension line approximately 1000 miles long from Nashville, Tenn., to Henderson, N. C. This ties together the hydro-electric systems of five companies operating in four states. In other words, all the great transmission systems of the South with the exception of that controlled by the Alabama Power Co. are interconnected. It is probably only a question of time until all properties will not only be interconnected but possibly owned and controlled by a master organization.

Among the advantages which follow from the interconnection of such systems none is greater than the improvement in the diversity factor. The difference of one hour in time between Henderson, N. C., and Nashville, Tenn., adds to the normal diversity factor of each system.

The United States Geological Survey has estimated the available power in the headwaters of the Appalachian Mountains at 2,800,000 hp. The estimate for all the systems of the South is about 5,000,000 hp. The Appalachian region has an enormous rainfall with a topography that is favorable to the development of low-head power plants. The illustration at the head of this article is typical of the Southern water powers. High heads as a rule do not exist and flumes and penstocks are little used. The absence of lakes in the region makes natural storage of water impossible.

Among the power companies in the United States and Canada having yearly outputs in excess of 100,000,000 kw.-hr., there are three Southern concerns, according to data given in the *Electrical World*, March 23, 1918.

System	Peak Load, Kw.	Yearly Output, Kw.-Hr.	Yearly Load Factor Per Cent.
Tennessee Power Co.	85,200	547,945,475	73.41
Alabama Power Co.	58,250	289,715,125	56.7
Georgia Railway & Power Co.	78,200	258,607,882	.....

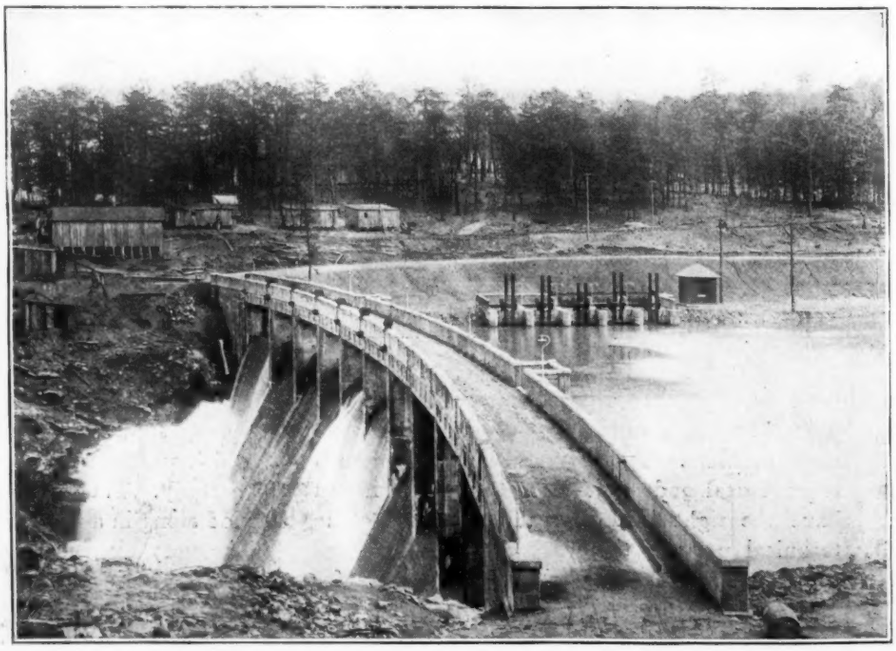


FIG. 1. INTAKE DAM AT TALLULAH FALLS, GEORGIA RAILWAY AND POWER CO.

*"Metallurgical and Chemical Engineering."

The properties owned by the Alabama Power Co. include several sites on the Coosa River, one site on the Tallapoosa River, one on Little River, and sites at Muscle Shoals on the Tennessee River. On these sites approximately 500,000 hp. can be developed. The hydro-electric stations of the company at present in operation are located at Lock 12 on the Coosa River, where a head of 68 ft. is available, and at Jackson Shoals, on Choccolocca Creek, where a head of 22 ft. is available. Sixty-cycle three-phase energy is generated at 6600 volts in the Coosa River plant and 2300 volts in the Jackson Shoals plant. The company has at present in operation 180 miles of steel-tower transmission lines equipped with suspension-type insulators and 00 stranded copper cable for transmitting energy at 110,000 volts to four substations over private rights-of-way. The substations are situated at Gadsden, Anniston, Jackson Shoals and Magella, near Birmingham. Substations operated at 22,000 volts are in operation at Talladega, Leeds, Lovick, Alexander City, Gadsden and Attalla. The high-tension substations are of the outdoor type. It is the purpose of the company to standardize these as to size and type on 3000-, 6000 and 10,000-kv.-a. ratings. At present 45,300 kv.-a. is installed in the four substations. The company has 25,-

FIG. 2. COLUMBUS POWER CO.

000 kw. of available steam auxiliary apparatus, comprising a 12,500-kw. steam-turbine station at Gadsden[1], containing two 6250-kv.-a. units, and a 15,000-kw. steam-turbine and reciprocating-engine plant. With the available steam auxiliary of 25,000 kw. operating as required and furnishing approximately 7.55 per cent. of the total kilowatt-hour output, 62,400 kw. of primary power at 50 per cent. load-factor can be delivered as soon as another hydro-electric unit is installed. The Anniston substation is a switching station for two

[1]Gadsden Steam Power Plant, "Power," Aug. 4, 1914.

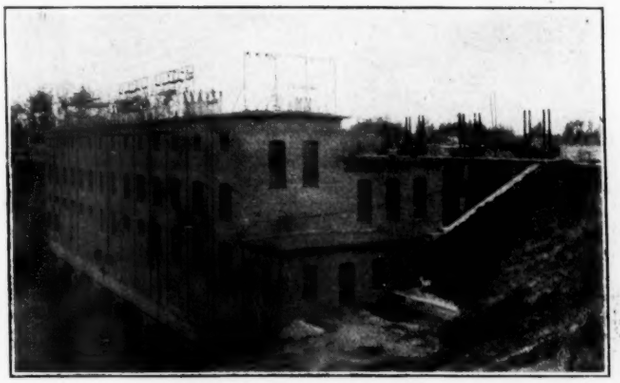


FIG. 4. YADKIN RIVER POWER CO., BLEWETT FALLS, N. C., HYDRO-ELECTRIC PLANTS FROM NORTHEAST

110,000-volt lines which pass through it. The Jackson Shoals substation is also a switching station for three 110,000-volt circuits from the north, south and west. The Magella substation will have an ultimate rating of 67,000 kilowatts.

Carolina Power and Light Company

The Carolina Power and Light Co., in addition to the property owned and directly operated, also controls the Yadkin River Power Co. and the Asheville Power and Light Co.

The last-named company operates the electric light and power service in Raleigh, Goldsboro, Henderson, Oxford, Sanford and Jonesboro, furnishing electric light and power service for manufacturing properties in Fayetteville, Clayton, Smithfield, Selma, Franklinton, Pine Level and Cumberland. It also supplies under contract the entire requirements of the municipal electric light and power systems in Smithfield, Selma and Clayton and all the privately owned electric light and power systems in Franklinton and Pine Level. The company operates 188 miles of high-tension transmission line connecting two hydro-electric and three steam plants with distributing systems in all the communities served. The larger of the hydro-electric plants is located at Buckhorn Falls on the Cape Fear River and has an installed capacity of 3300 hp. The smaller is a plant of 530 hp. on the Neuse River near Raleigh. The company has also in reserve a modern steam plant of 5000 hp. capacity at Raleigh, one of 950 hp. at Goldsboro and one of 300 hp. at Henderson. It operates nine substations with an aggregate capacity of 23,000 horsepower.

The properties of the Carolina Power and Light Co.

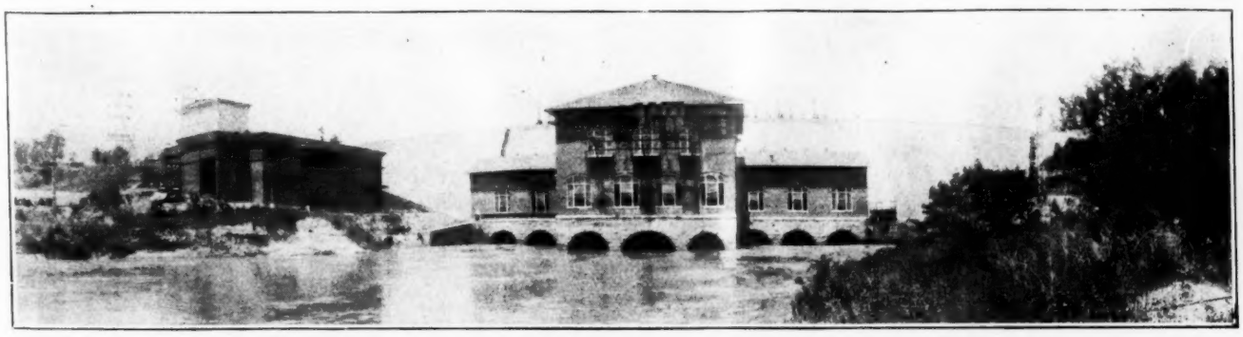


FIG. 3. THE GREAT FALLS PLANT OF THE SOUTHERN POWER CO.

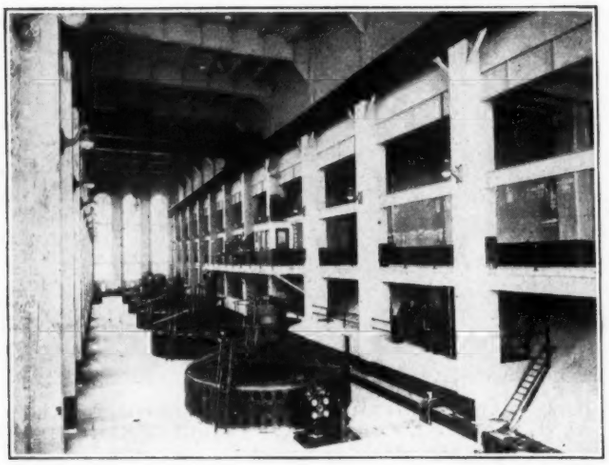


FIG. 5. 90,000-HP. GENERATORS—COOSA RIVER INTERIOR VIEW LOCK NO. 12 POWER HOUSE

are situated in the heart of the North Carolina industrial district. A large part of the electric energy sold by the company is supplied to cotton mills, cotton gins, cottonseed-oil mills, fertilizer works, veneer mills, furniture factories, machine shops, brick plants and other manufacturing establishments, and to municipalities for pumping water.

The Yadkin River Power Co. owns and operates a hydro-electric development on the Yadkin River, at Blewett Falls, near Rockingham, N. C., with an initial installed capacity of 32,000 hp. It has in operation 184 miles of high-tension transmission lines, located on private right-of-way, and 49 miles of distributing lines, five substations, with a total capacity of 4100 hp.; lighting and power systems in Rockingham, Hamlet, Wadesboro and Lilesville, N. C., and Cheraw, S. C., and an electric-power service in Lumberton, N. C., The transmission lines are connected with those of the Carolina Power and Light Co. and the Southern Power Co. The power station at Blewett Falls is one of the most modern in the South. It is 285 ft. long by 70 ft. wide, three stories in height, and is built of steel and brick with concrete foundations, floor and roof. The dam is of solid concrete construction. It has a total length of 1470 ft. and a maximum height of 50 ft. The dam has created a reservoir eight miles in length with a total area of 2500 acres. The station was placed in regular operation in June, 1912.

Like the properties of the Carolina Power and Light Co., those of the Yadkin River Power Co. are situated in the Carolina cotton-mill district, and a large part of the electric energy sold by the company is supplied to cotton mills, cotton gins and cottonseed-oil mills. It also supplies power to numerous other industrial plants, such as fertilizer works, veneer mills, furniture factories, brick plants and railroad shops, and to municipalities for pumping water.

COLUMBUS POWER COMPANY

The Columbus Power Co. has three hydro-electric developments on the Chattahoochee River, two at Columbus having an aggregate rating of 9000 kv.-a. and one at Goat Rock, 15 miles north of Columbus, having 13,750 kv.-a. installed, making the total available 22,750 kv.-a. The City Mills development at Columbus comprises five generators with an aggregate rating of 1000 kw., the head being 10 ft. The North Highlands development has six generators, with an aggregate rating of 6900 kw., and waterwheels operating under a head of 42 ft. The Goat Rock development, where a head of 72 ft. is available, has three generators, two of which are rated at 3750 kw. and the other at 5000 kw. Three-phase 60-cycle energy is generated at 5500 volts and 11,000 volts. Two 4000-kw. transformers step up the potential to 66,000 volts for transmission. A 11,000-volt line on wooden poles with pin-type insulators connects the Columbus and Goat Rock properties, and a

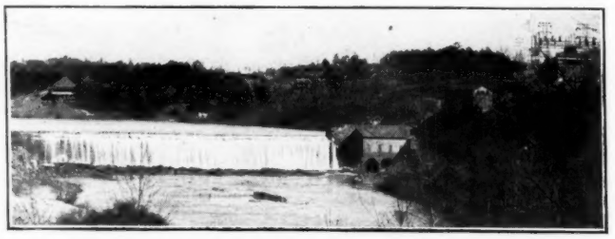


FIG. 7. DUNLAP PLANT, GEORGIA RY. AND POWER CO.

60-mile steel-tower line equipped with suspension-type insulators and operating at 66,000 volts extends from Goat Rock at Newnan. There is 18 miles of wooden-pole line operating at 11,000 volts connecting Newnan and Hogansville. Four main substations are connected to the system: One at Columbus, rated at 1600 kw.; one at West Point, rated at 1875 kw.; one at La Grange, rated at 1875 kw.; and the fourth at Newnan, rated at 4000 kw. The system operates continuously on a 40 per cent. load-factor basis, and auxiliary steam-generating apparatus of the capacity of 3000-kw. turbo-generators is available. Provision is made for the transfer of 3000 kw. between the Columbus Power Co.'s system and the system of the Georgia Railway and Power Co.

FIG. 6. THE ROCKY CREEK PLANT OF THE SOUTHERN POWER COMPANY

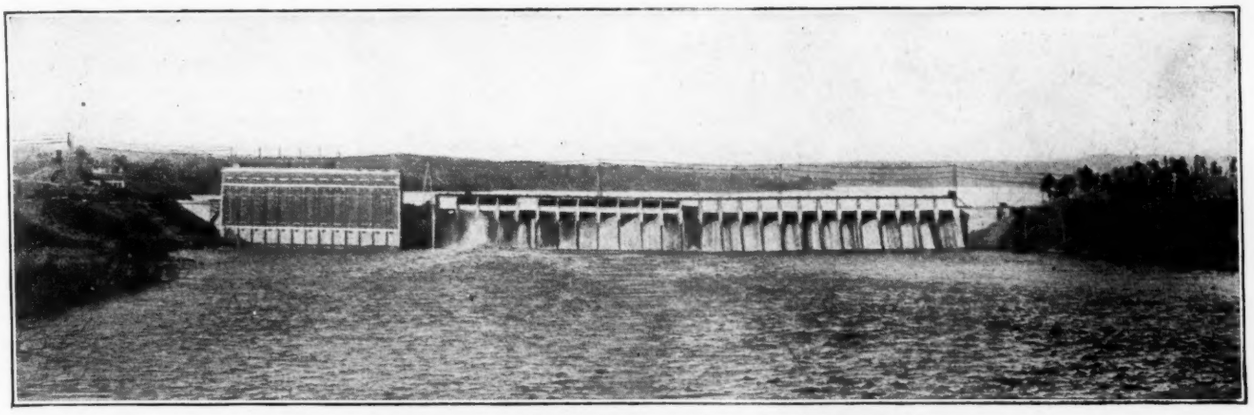


FIG. 8. LOCK 12, HYDRO-ELECTRIC PLANT—DOWNSTREAM VIEW

GEORGIA RAILWAY AND POWER COMPANY

The present coal-supply conditions emphasize the importance of existing water-power generating plants and the vital need of additional developments.

The 100,000-hp. plant of the Georgia Railway and Power Co. at Tallulah Falls[2] was barely finished when the rapid increase in the demand for hydro-electric power forced the company to undertake the construction of additional water-power developments, which, when completed, will nearly double the present capacity of its existing water-power plants.

The growth of the business in the last six years is shown in the following table of yearly outputs in kilowatt-hours:

1912	68,400,642	1915	179,976,596
1913	80,763,025	1916	211,872,638
1914	145,684,803	1917	258,607,802

This shows an increase in that period of nearly 300 per cent.

The water power furnished by the company to its customers in 1917 would have required approximately 475,000 tons of coal if generated by them by steam. The additional water power which it is estimated will be generated at the new plants now under construction, and which has already been largely sold, will take the place of and save approximately 400,000 tons of coal annually—a total combined saving of approximately 875,000 tons of coal per annum.

The new developments now being constructed are as follows:

[2]Tallulah Falls Development, "Power," Jan. 27, 1914.

The Burton storage reservoir, to be in service by the end of year 1918, is three miles north of the present Mathis storage reservoir and will flood approximately 3000 acres of land. It requires the construction of a dam 700 ft. long and 100 ft. high of cyclopean masonry. The reservoir will store approximately five billion cubic feet of water. The water contained in this reservoir, exclusive of the average flow of the river, will produce at the Tallulah Falls and Tugaloo generating plants 65,000,000 kw.-hr. and will increase the annual capacity of those plants to that extent. This reservoir will also make possible the equalization of the river flow, or in other words, the even distribution of all available rainfall run-off from its contributary watershed throughout every month in the year, the stored water being drawn out for use in the dry months and replaced in the wet season. The water that can be stored in this reservoir is equivalent to the available energy in 130,000 tons of coal.

The Tugaloo development is about two miles below the present Tallulah Falls power house on the Tugaloo River where the Tallulah and the Chattooga Rivers come together and form the Tugaloo. The water available at this point for power purposes comes from both the Tallulah and the Chattooga Rivers. The average flow of the river, including the effect of the Mathis storage reservoir, it is estimated will produce at this plant approximately 120,000,000 kw.-hr. It will require only 1½ miles of transmission line to connect this development with the present Tallulah Falls transmission lines. The Tugaloo dam of cyclopean masonry is

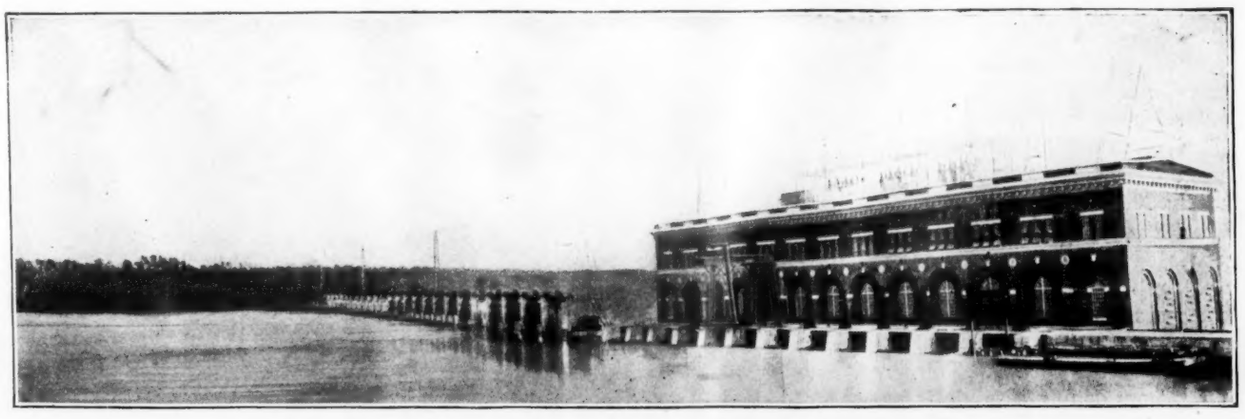


FIG. 9. LOCK 12, HYDRO-ELECTRIC PLANT—UPSTREAM VIEW

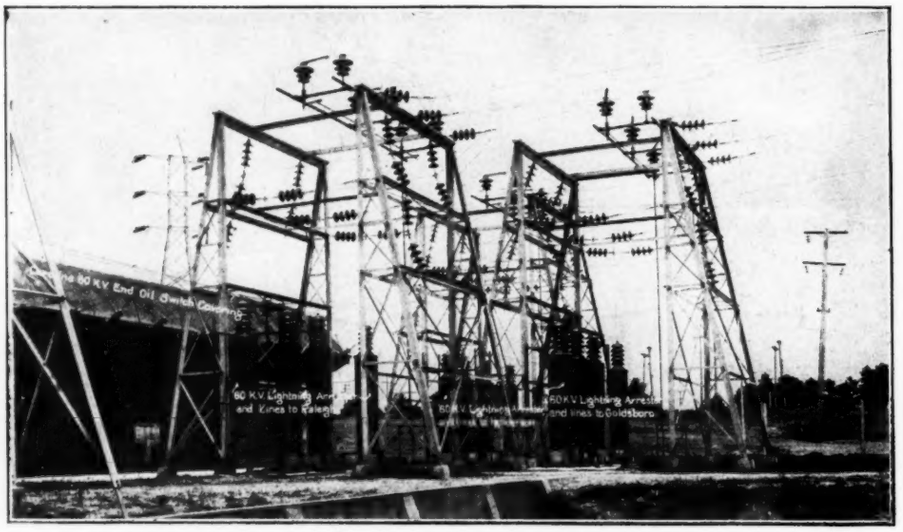

60 K.V. End Oil Switch Covering
60 K.V. Lightning Arr
and Lines to Raleigh
60 K.V. Lightning
60 K.V. Lightning Arrest
and lines to Goldsboro

FIG. 10. METHOD (N. C.) OUTDOOR SUBSTATION LOOKING NORTH. CAROLINA POWER AND LIGHT CO.

800 ft. long and 140 ft. high. The Tugaloo plant will develop approximately 65,000 hp., and it is estimated that two years time will be necessary in which to complete it.

The Tallulah Falls power plant was constructed and designed for six units of 12,000 kw., or about 17,000 hp. each. Five units are now installed. The sixth has been ordered and will be ready for service some time during the summer of 1918.

Contracts were let for all the required equipment for the three developments during the summer of 1917 and construction is now actively under way.

The estimated total cost of this construction is $5,000,000. The necessary financing to carry on the work was completed in June, 1917. The company was fortunate in this respect because the war has since brought such changed financial conditions that the necessary capital could not be secured at the present time and this has been continuously true since the financial arrangements were concluded.

The Georgia Railway and Power Co. upon completion of the plants now under construction will have waterpower plants of approximately 200,000 hp. developed and in service. The company controls approximately 300,000 undeveloped horsepower in addition, or a total developed and undeveloped of approximately 500,000 horsepower.

A large part of the power generated by the company is used by enterprises making war materials or supplies necessary to the successful prosecution of the war. This shows how doubly vital it is in war times that money for such developments should be available. It also points the lesson that many of us appreciated years ago; namely, the necessity of a broad and generous policy on the part of the Government in the development of the water powers of the nation. Water power should be provided to meet the increasing demand due to the war. But war conditions have made money unobtainable through the usual banking channels. From now on and as long as present conditions exist such developments cannot be made unless the National Government will furnish the needed capital with which to carry on the work.

The French government realized early in the war the vital need of largely increasing the available power for industrial purposes from other sources than coal and is now constructing water-power developments in Southern France on a large scale under the direction of an American engineer.

The power actually furnished by the Georgia Railway and Power Co. in 1917, if generated by its customers by steam, would have required 11,875 cars of coal of 40 tons capacity each, and the estimated power which will annually be generated by the plants now being constructed, will be the equivalent of 10,000 cars of coal of 40 tons capacity each additional, or a combined saving in coal consumption per annum of 21,875 cars of coal of 40 tons capacity each, or a total of 875,000 tons. If the remaining 300,000 hp. of undeveloped water power

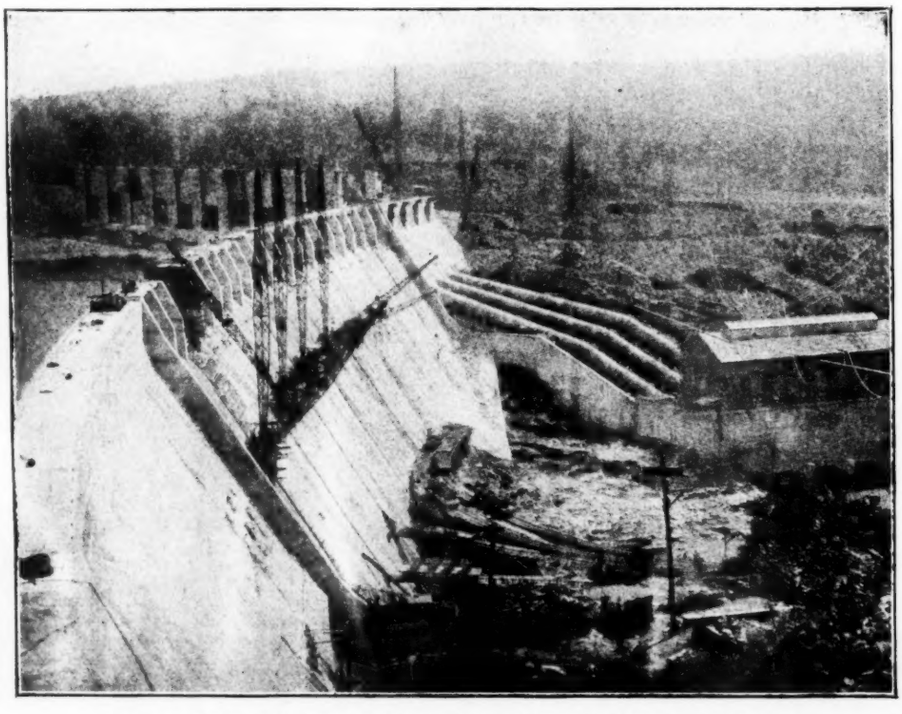


FIG. 11. THE TALLASSEE POWER CO., YADKIN RIVER, BADIN, N. C.

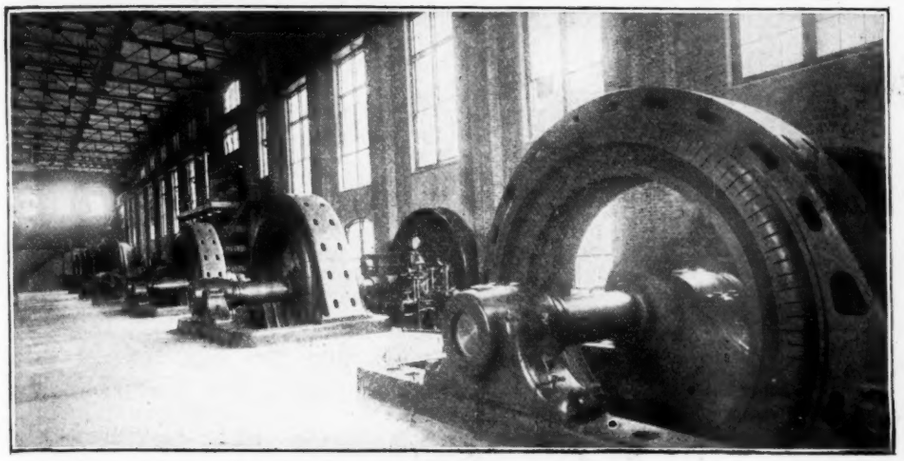


FIG. 12. YADKIN RIVER POWER CO. THREE 4500 KV.-A., THREE 6000 KV.-A. 4000 VOLT 60 CYCLE G. E. GENERATORS

controlled by the company could be developed and put to work, the saving would be two and one-half times as great, or a total of 54,687 cars of coal of 40 tons capacity each, or 2,187,480 tons of coal conserved with all its collateral economies.

If capital were now available for the construction of the necessary generating plants sufficient to utilize the undeveloped water power controlled by the Georgia Railway and Power Co., and the National Government would bring about the electrification of the steam railroads, all the important railroad mileage in Georgia would be operated by electric power generated by that company. The operating expenses of the railroads themselves would be materially reduced, their service much improved, and in addition the coal now consumed by them conserved, and the present regular business of the company supplied and developed as at present. This under present and past conditions is worth while.

Southern Power Company

The Southern Power Co. is connected to the Carolina Power and Light Co. at a point between Durham and Raleigh, N. C., and with the Georgia Railway and Power Co. of Tallulah Falls. The location and maximum ratings of the company's various stations are given in the accompanying table.

Electricity is generated at 2200, 6600 and 11,000 volts, three-phase, sixty-cycle, there being one 8000-kv.-a. 2300-volt and two 8000-kv.-a. 11,000-volt steam-driven generators, twenty-two 3000-kv.-a. 3000-volt generators, three 7800-kv.-a. 6600-volt generators, four 900-kv.-a. and 750-kv.-a. 11,000-volt generators. The last 33 units are of the water-wheel type. There are also connected to the system 65 high-voltage transformers having an aggregate rating of 169,400 kv.-a. The lines of the company cover a territory of 300 miles in a northeasterly and southwesterly direction and 100 miles in a northwesterly and southeasterly direction. The first transmission system of the company is designed for 11,000 volts. With the expansion of the company and its activities, a 44-000-volt transmission system was built, and all of the recent transmission lines erected by the company have been designed for 100,000 volts. All lines are looped in together, and the 11,000-volt and 100,000-volt systems are tied together with tie-in transformers. Aluminum and copper are both used for conductors, the size ranging from No. 4 solid copper to No. 000 stranded. By far the greatest amount of the lines are of No. 00 copper stranded and No. 00 equivalent aluminum stranded. This is run on both steel towers and wooden poles with pin-type and suspension-type insulators, depending upon the voltage. There are 103 substations connected to the system, con-

DATA ON SOUTHERN POWER COMPANY'S STATIONS

Location	Maximum Rating	Head, Ft
Great Falls, S. C.	24,000 Kw.	72
Rocky Creek, S. C.	24,000 Kw.	63
Ninety-nine Islands, S. C.	18,000 Kw.	72
Catawba, S. C.	6,600 Kw.	25
Lookout Shoals, N. C. (under construction)	24,000 Kw.	76
Greenville, S. C. (steam)	8,000 Kv.-a.	....
Greensboro, N. C. (steam)	8,000 Kv.-a.	....
Mount Holly, N. C. (steam)	8,000 Kv.-a.	....

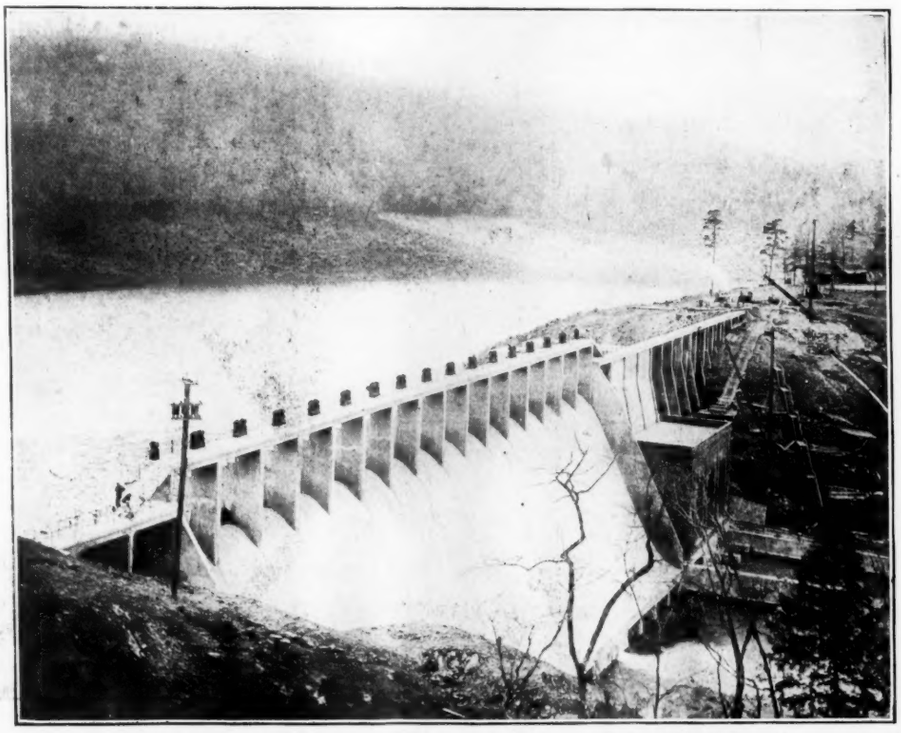


FIG. 13. MATHIS DAM, GEORGIA RAILWAY AND POWER CO.

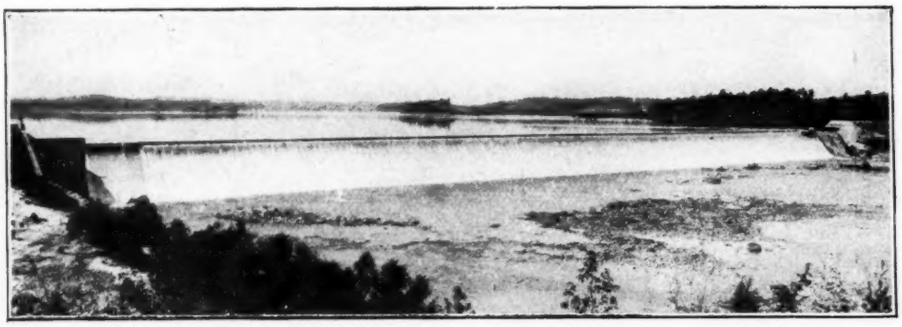


FIG. 14. YADKIN RIVER POWER CO., BLEWETT FALLS, DAM AND POND

taining 352 transformers, with an aggregate rating of 241,162 kv.-a.

The circuits of the Southern Power Co. are connected on the north with those of the Carolina Power and Light Co. with two 100,000-volt lines. The amount of power that can be transferred is limited only by the carrying capacity of these lines, as no transformers are required in order to effect this connection. On the south the Southern Power Co.'s system is connected with that of the Georgia Railway and Power Co. of Tallulah Falls, with two 100,000-volt lines, and the power which can be transferred between the two companies at this point is limited only by the carrying capacity of the lines.

It should be pointed out that the rating of the hydro-electric stations of the Southern Power Co. is based upon the continuous rating for the continuous amount of 12-hour power which the station can generate for eight months in the year. The company maintains three 8000-kv.-a. turbo-generator steam plants for emergency and supplementary service. The fires under the boilers are banked, and all three stations can be got under way to feed energy to the lines within fifteen minutes.

TENNESSEE POWER CO.

The present hydro-electric stations owned and operated by the Tennessee Power Co. are as follows:

Ocoee No. 1, located in Polk County at Parksville, Tenn., on the Ocoee River, approximately 50 miles from Chattanooga. The equipment in this plant consists of five horizontal direct-connected waterwheel-driven generators, each one having a capacity of 3750 kw., the total station capacity being 18,750 kw. The dam at this plant backs up the Ocoee River, forming a lake approximately eight miles long. Sufficient water is impounded to operate the station over a period of two or three weeks during reduced stream flow. Ocoee No. 2,[3] located in Polk County on the Ocoee River, about ten miles east of Parksville. This plant is equipped with two horizontal waterwheel-driven generators, each having a capacity of 7500 kw., the total capacity of the station being 15,000 kw. This plant uses the stream flow from the Ocoee River, which is diverted by means of a low dam, five miles above the power station, from which the water is conveyed by means of a flume to a forebay above the power house. The operating head at this plant is 255 feet.

Great Falls Station, at the northwest corner of Warren County, about halfway between Nashville and Chattanooga. This plant uses the flow of the Caney Fork and Collins Rivers. Just below the confluence of the two rivers a low concrete dam diverts the two streams, which are conveyed to the waterwheel by means of a tunnel and penstock. The plant is equipped with one vertical waterwheel-driven generator, the capacity being 9750 kilowatts.

Hales Bar,[4] on the Tennessee River about 20 miles west of Chattanooga. This plant is equipped with fourteen 3000-kw. vertical turbines, the total capacity of the

[3]Completion of the Hales Bar Works, "Power," Dec. 2, 1913.
[4]Hydro-Electric Plants of the Tennessee Power Co., "Power," May 17, 1914.

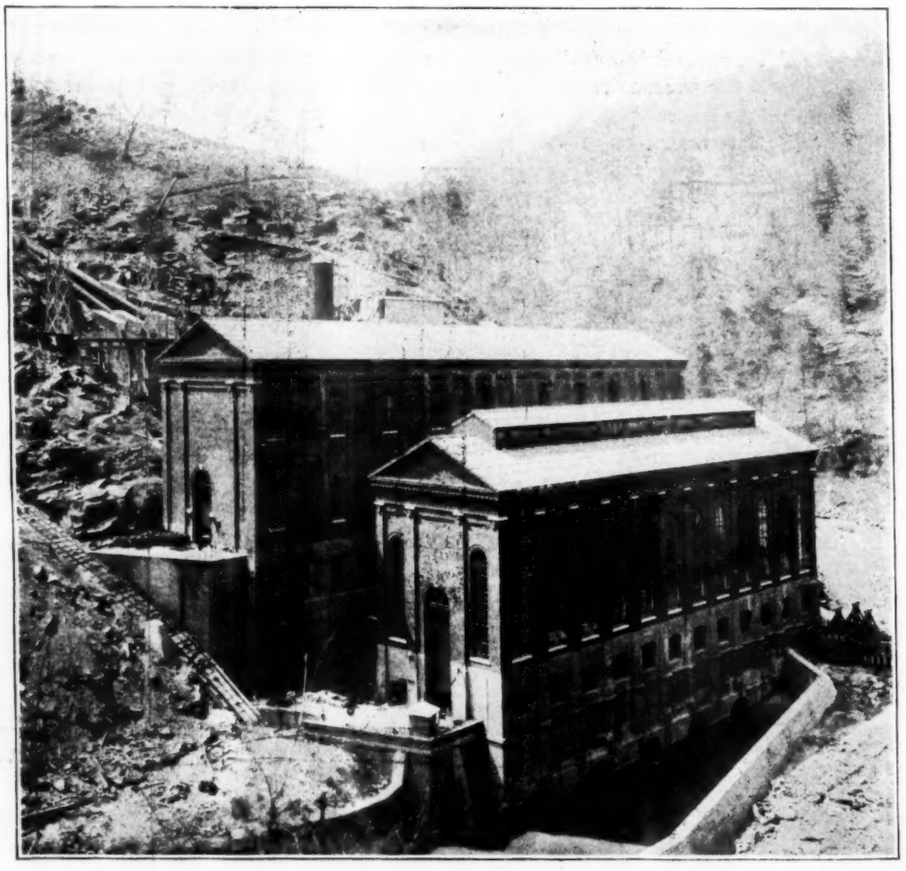


FIG. 15. TALLULAH FALLS POWER HOUSE, GEORGIA RAILWAY AND POWER CO.

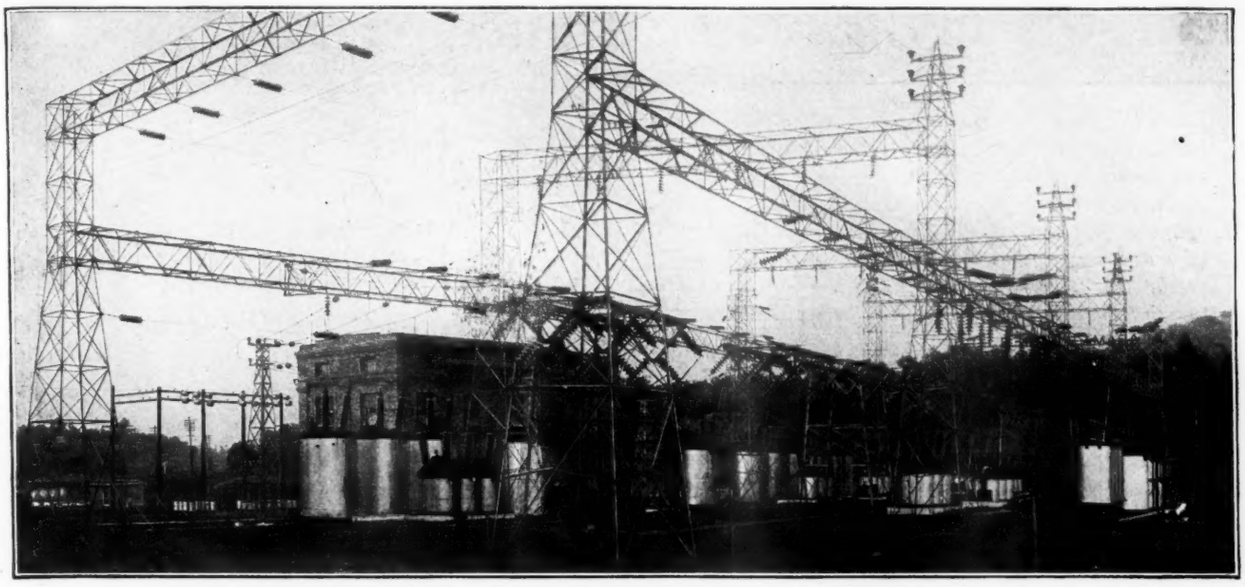


FIG. 16. SUBSTATION—ALABAMA POWER CO., COOSA RIVER HYDRO-ELECTRIC PLANT

station being 42,000 kw. The concrete dam across the river at the power-house site backs up the water and makes the river navigable to Chattanooga. The spillway is 1200 ft. long. The dam is of necessity provided with a boat-lock which is operated by the Government.

The combined capacity of the present hydro-electric stations is 85,000 kilowatts.

Additional developments have been considered, and rights obtained for three more stations on the Ocoee River, to be known as Ocoee Nos. 3, 4 and 5. The additional capacity from these three stations will be in the neighborhood of 35,000 kilowatts.

The Tennessee Power Co. has an arrangement with the Chattanooga Railway and Light Co., the Nashville Railway and Light Co. and the Knoxville Railway and Light Co. whereby the steam plants at these three cities may be operated at the direction of the Tennessee Co. to supplement the output from the hydro plants during low water. The capacities of the steam stations are as follows:

	Kilowatts
Chattanooga	5,000
Nashville	15,000
Knoxville	4,000
Total	24,000

The Tennessee Power Co. generates the electrical energy used in Chattanooga, Nashville, Knoxville and a large number of the small cities in eastern Tennessee. In addition it supplies power to the Aluminum Company of America at Maryville, Tenn., 16 miles south of Knoxville, and also to the American Zinc Co. at Mascot, Tenn., 15 miles northeast of Knoxville. The total transmission-line mileage of this system is approximately 600.

The rates for electrical energy are in accordance with the following tabulation:

A fixed charge of $1.25 per month per kilowatt of maximum demand based on the highest fifteen minute demand during the month, but in no event shall the fixed charge be less than 60 per cent. of the total kilowatt capacity contracted for.

In addition to the above demand charge, the following kilowatt-hour charge for electrical energy consumed during the month:

	Kilowatt-Hours
4c. per kw.-hr. for the first	500
2c. per kw.-hr. for the next	1,000
1½c. per kw.-hr. for the next	1,500
1c. per kw.-hr. for the next	17,000
0.7c. per kw.-hr. for all over	20,000

A discount of 5 per cent. will be allowed upon all bills paid within ten days from their date.

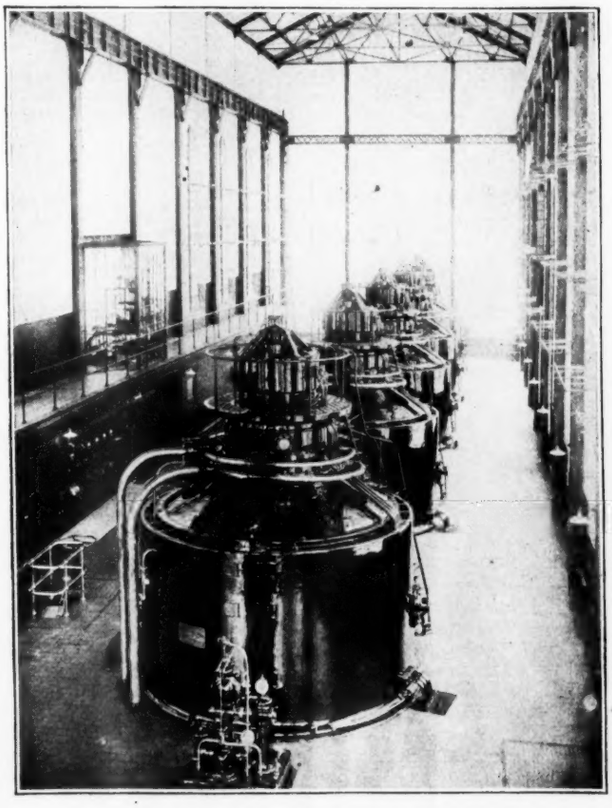


FIG. 17. GENERATORS, TALLULAH FALLS POWER HOUSE, GEORGIA RAILWAY AND POWER CO.

Coals of the United States

Gives the proximate analyses on the "as received" basis of typical coals of the United States. These analyses are given as the first of some articles on fuels, and types of stokers and furnaces best adapted to them, published to assist consumers who are confronted with the, to them, unusual combustion problems by reason of the zone system for the distribution of bituminous coal recently put into effect by the Fuel Administration.

TO GREATLY cut down transportation of coal on the railroads and to insure a larger supply of the Eastern bituminous coals to the states of the Atlantic Seaboard, the zone system for the distribution of bituminous coal has been put into effect by the Fuel Administration. Nearly all the states of the Middle West, heretofore large consumers of the high-grade coals of West Virginia and the East, must learn to burn the high-volatile, high-ash coals, also the lignites, in which the Middle West, North Dakota and Texas abound.

Power for May 14 gave full particulars about the zone system as it affects power plants particularly. See that issue to learn what coals are permitted to come into your state or zone. Knowing the coal you have been using, you can, by reference to the table here, find the chief differences between the coal or coals you now use and those you will hereafter use.

The analyses are selected from Bulletin No. 22 of the Bureau of Mines. The names on the same lines with the figures are those of the mines or towns.

TABLE OF PROXIMATE ANALYSES

	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	British Thermal Units
			Per Cent.			
ALABAMA						
Bibb County						
Belle Ellen	3.12	31.41	59.70	5.77	1.24	14,031
Garnsey	3.03	30.94	55.31	10.72	0.49	13,034
	2.72	29.46	53.46	14.36	0.55	12,461
Blount County						
Lehigh	2.93	29.06	65.28	2.73	0.65	14,693
Jefferson County						
Cardiff	2.88	29.56	56.91	10.65	2.04	13,459
Dolomite	3.16	25.40	67.75	3.69	0.56	14,616
ARKANSAS						
Franklin County						
Denning	2.91	12.65	66.93	17.51	3.12	12,312
Johnson County						
Coal Hill	1.38	14.76	76.91	6.95	1.52	14,330
Ouachita County						
Lester	39.43	26.49	24.37	9.71	0.49	6,356
Sebastian County						
Bonanza	1.99	15.90	75.05	7.06	1.05	14,087
Burma	0.80	17.80	72.71	8.69	1.95	14,281
Huntington	3.24	17.46	66.69	12.61	1.24	13,129
Jenny Lind	0.95	17.91	71.52	9.62	2.07	14,096
	2.19	19.47	66.71	11.63	1.28	13,464
COLORADO						
Boulder County						
Lafayette	19.15	30.82	44.27	5.76	0.25	9,61
Delta County						
Bowie	3.29	39.74	52.16	4.81	0.62	13,379
El Paso County						
Colorado Springs	22.19	34.58	37.40	5.83	0.47	8,503
Fremont County						
Canon City	11.19	36.77	45.75	6.29	0.92	11,286
Garfield County						
Cardiff	12.20	34.23	48.60	4.97	0.48	11,104
Newcastle	3.51	38.38	53.17	4.94	0.54	13,266
South Canon	7.44	36.18	53.90	2.48	0.47	12,685
Gunnison County						
Crested Butte	2.98	33.62	56.16	7.24	0.39	13,428
Somerset	5.49	35.65	55.79	3.07	0.60	13,217
Pitkin County						
Coal Basin	0.96	21.49	68.93	8.62	0.52	14,330
Rio Blanco County						
Meeker	9.41	37.97	45.38	7.24	0.75	11,324
Routt County						
Axial	13.15	36.44	47.54	2.87	0.57	11,390

TABLE OF PROXIMATE ANALYSES—Continued

	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	British Thermal Units
			Per Cent.			
ILLINOIS						
Franklin County						
Zeigler	9.58	29.18	50.24	11.00	0.52	11,428
Logan County						
Lincoln	14.77	32.90	39.75	12.58	3.95	10,406
Madison County						
Collinsville	11.87	36.57	39.98	11.58	4.75	10,768
Livingston	14.25	35.52	40.79	9.44	3.72	10,892
Saline County						
Harrisburg	7.81	33.54	50.27	8.38	2.36	12,418
INDIANA						
Greene County						
Linton	13.53	33.54	45.38	7.55	0.95	11,738
	10.30	36.31	41.64	11.75	4.23	11,218
Pike County						
Hartwell	10.57	35.03	42.75	11.65	3.87	11,266
Sullivan County						
Mildred	13.25	35.81	41.78	9.16	1.87	11,360
Vigo County						
Terre Haute	10.68	37.17	39.91	12.24	4.38	11,261
Warrick County						
Boonville	10.41	39.18	41.96	8.45	3.51	11,819
IOWA						
Lucas County						
Chariton	18.69	31.80	41.78	7.73	2.39	10,505
Marion County						
Hamilton	14.21	33.17	37.40	15.22	4.66	10,019
Wapello County						
Laddsdale	11.35	38.65	39.49	10.51	4.72	11,345
KANSAS						
Cherokee County						
Scammon	2.54	35.31	52.28	9.87	4.47	13,340
Crawford County						
Yale	2.44	35.16	51.80	10.60	5.63	13,043
Linn County						
Jewett	11.13	28.83	47.44	12.60	2.41	11,219
KENTUCKY						
Bell County						
Straight Creek	2.91	36.01	57.55	3.53	0.89	14,322
Hopkins County						
Barnsley	7.98	37.55	45.17	9.30	4.03	11,965
Earlington	8.49	38.05	46.36	7.10	3.53	12,344
Johnson County						
Van Lear	6.43	36.20	54.13	3.24	1.17	13,455
Ohio County						
McHenry	10.03	36.06	46.24	7.67	2.56	12,076
Pike County						
Hellier	3.41	32.08	58.78	5.73	0.53	13,928
Webster County						
Wheatcroft	6.29	31.97	54.13	7.61	1.35	12,874
MARYLAND						
Alleghany County						
Eckhart	2.3	14.5	75.0	8.2	1.10	14,020
Washington	2.31	17.49	71.51	8.69	1.62	14,022
Frostburg	3.06	17.01	73.54	6.39	0.96	14,274
Lord	2.47	18.17	73.06	6.30	0.79	14,328
Midland	2.54	18.22	72.01	7.23	0.92	14,283
MISSOURI						
Adair County						
Kirksville	14.59	32.05	39.45	13.91	3.69	10,260
Novinger	17.19	34.05	39.48	9.28	2.76	10,598
Audrain County						
Vandalia	10.36	39.28	38.03	12.33	4.89	11,347
Bates County						
New Home	4.92	38.28	42.28	14.52	5.34	11,975
Henry County						
Windsor	13.51	33.24	41.88	11.37	4.08	10,779
Lafayette County						
Corder	12.34	34.36	41.97	11.33	4.55	10,998
Macon County						
Bevier	14.74	38.53	38.95	7.78	3.79	11,185
Randolph County						
Higbee	13.38	34.17	42.43	10.02	4.48	11,084
Ray County						
Camden	15.83	32.80	41.46	9.91	2.97	10,622
MONTANA						
Broadwater County						
Lombard	2.78	24.53	42.95	29.74	8.23	10,062
Carbon County						
Bear Creek	10.05	37.22	46.71	6.02	1.44	11,194
Bridger	14.83	26.93	44.89	13.35	0.33	10,037
Red Lodge	11.05	35.90	42.08	10.97	1.73	10,539
Cascade County						
Belt	6.37	27.55	45.20	20.88	2.04	9,866
Eden	4.54	27.44	47.95	20.07	4.09	10,472
Stockett	6.01	28.43	51.42	14.14	2.38	11,153
Chouteau County						
Chinook	21.41	28.00	41.60	8.99	0.58	8,937
Havre	22.84	29.31	34.61	13.24	0.80	7,898
Custer County						
Miles	29.21	26.15	35.45	9.19	0.75	7,668
Dawson County						
Glendive	34.55	35.34	22.91	7.20	1.10	7,090

TABLE OF PROXIMATE ANALYSES—Continued

	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	British Thermal Units
			Per Cent.			
Fergus County						
Buffalo	17.03	27.34	43.83	11.80	4.14	8,894
Lewistown	12.31	28.41	51.31	7.97	3.88	11,149
Gallatin County						
Chestnut	2.05	16.42	73.22	8.31	0.86	14,092
Storrs	4.01	34.54	45.48	15.97	0.51	11,860
Musselshell County						
Aldridge	1.07	19.79	54.74	23.60	0.44	11,320
Sweet Grass County						
Nye	6.75	32.37	44.47	16.41	0.53	10,679
Yellowstone County						
Buckey	16.95	30.78	39.64	12.63	0.49	8,597
Musselshell	22.77	27.00	45.58	4.65	0.32	8,863
Roundup	13.4	28.0	52.4	6.2	0.40	11,050
NEW MEXICO						
Colfax County						
Blossburg	2.25	33.19	52.19	12.37	0.75	13,030
Brilliant	2.19	35.95	50.75	11.11	0.57	13,063
Raton	2.12	36.06	50.22	11.60	0.64	12,965
Yankee	5.02	36.78	46.20	12.00	0.56	12,064
M'Kinley County						
Clarkville	14.49	37.08	44.58	3.85	0.41	11,468
Gallup	9.68	41.42	40.82	8.08	1.55	11,623
	11.00	42.63	42.44	3.93	0.55	11,885
San Juan County						
Putnam	15.79	34.99	39.85	9.37	1.78	9,970
Santa Fe County						
Madrid	5.70	2.18	86.13	5.99	0.69	13,268
Socorro County						
Carthage	3.91	38.87	46.82	10.40	0.70	12,742
NORTH DAKOTA						
Billings County						
Medora	38.45	28.02	27.84	5.69	0.54	.....
Bowman County						
Scranton	41.43	23.86	28.45	6.26	0.74	6,241
M'Lean County						
Wilton	40.53	27.05	27.37	5.05	0.76	6,644
Stark County						
Lehigh	42.06	24.55	25.73	7.66	1.13	6,158
Ward County						
Tasker	36.64	22.64	30.74	9.98	0.45	6,394
Williams County						
Williston	36.60	32.93	25.69	4.78	0.48	6,824
OHIO						
Belmont County						
Bellaire	3.10	40.76	50.11	6.03	3.42	13,595
Neffs	3.99	38.77	49.17	8.07	3.49	13,102
Guernsey County						
Danford	6.28	35.81	50.61	7.30	3.55	12,701
Jackson County						
Wellston	7.71	38.32	42.02	11.95	4.61	11,515
Jefferson County						
Bradley	4.06	38.49	49.70	7.75	3.67	13,147
Rush Run	4.34	35.53	52.83	7.30	1.72	13,178
Perry County						
Dixie	8.92	38.58	46.65	5.85	3.00	12,328
Shawnee	10.78	34.86	48.23	6.13	1.11	11,993
Vinton County						
Clarion	6.79	40.01	45.54	7.66	3.34	12,514
OKLAHOMA						
Coal County						
Lehigh	6.50	39.01	45.18	9.31	3.67	11,842
Haskell County						
Chant	2.37	19.26	69.54	8.83	1.03	13,840
Latimer County						
Wilburton	2.96	35.97	55.95	5.12	1.05	13,707
Okmulgee County						
Henryetta	8.87	34.82	47.68	8.63	1.62	12,096
Pittsburg County						
Hartshorne	4.45	36.15	48.40	11.00	1.52	12,607
OREGON						
Coos County						
Beaver Hill	14.27	34.46	43.20	8.07	0.74	9,626
Libby	20.84	34.04	36.75	8.37	1.17	10,348
Marshfield	19.7	31.5	35.0	13.8	0.80	8,400
PENNSYLVANIA						
Allegheny County						
Bruceton	3.67	34.03	56.84	5.46	1.37	13,874
Cambria County						
Bakerton	3.3	16.5	74.6	5.6	1.10	14,422
Sterling	2.7	19.5	71.1	6.7	1.70	14,160
Johnstown	2.03	14.47	75.31	8.19	2.26	14,081
South Fork	1.13	15.95	75.2	7.72	1.35	14,387
Stineman	2.1	15.0	77.7	5.2	1.11	14,630
Windber	2.4	14.5	75.0	8.1	1.90	14,200
Clearfield County						
Grampian	4.1	23.0	66.8	6.1	1.91	14,000
Madera	2.4	20.5	70.8	6.3	1.66	14,330
Fayette County						
Connellsville	2.82	29.97	59.84	7.37	1.22	13,991
East Millsboro	4.08	32.44	53.98	9.50	1.64	13,268
Lackawanna County						
Scranton, anthracite culm	5.41	7.02	71.79	15.78	0.74	12,047
Somerset County						
Jerome	3.67	15.62	72.84	7.87	0.77	13,808
Washington County						
Acheson	2.60	32.46	59.31	5.63	1.19	14,184
Anderson	1.70	37.20	55.83	5.27	1.13	14,335
Ellsworth	3.01	33.46	58.70	4.83	0.73	14,197

TABLE OF PROXIMATE ANALYSES—Concluded

	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	British Thermal Units
			Per Cent.			
TENNESSEE						
Campbell County						
Gatliff	4.25	35.31	56.31	4.13	0.93	13,666
Lafollette	3.03	34.01	58.05	4.91	1.77	13,858
Marion County						
Orme	3.31	31.71	51.87	13.11	1.30	12,193
TEXAS						
Houston County						
Crockett	33.50	39.50	16.25	10.75	0.56	7,142
Milam County						
Olsen	36.01	27.95	28.66	7.38	0.77	7,132
Wood County						
Hoyt	28.86	35.96	27.26	7.92	0.50	7,996
UTAH						
Carbon County						
Castlegate	5.42	36.32	52.16	6.10	0.54	12,220
Emery County						
Woodside	9.01	31.78	51.03	8.18	0.46	10,863
Iron County						
Cedar City	10.35	36.33	43.70	9.62	5.82	10,874
Summit County						
Coalville	14.07	37.21	42.46	6.26	1.28	10,471
VIRGINIA						
Montgomery County						
Blacksburg	2.98	10.94	64.14	21.94	0.68	11,669
Russell County						
Dante	2.28	35.69	55.03	7.00	0.66	13,936
Tazewell County						
Pocahontas, Baby	1.63	17.17	75.34	5.86	0.75	14,672
	5.89	17.26	72.61	4.24	0.79	14,256
	3.8	15.5	77.8	2.92	0.63	14,860
Wise County						
Toms Creek	3.05	31.65	60.82	4.48	0.67	14,470
WASHINGTON						
King County						
Bayne	5.06	33.82	42.69	18.43	0.63	11,063
	5.35	33.03	47.11	14.51	0.70	11,590
Black Diamond	7.98	37.69	45.95	8.38	0.45	11,732
Coal Creek	12.05	36.82	40.72	10.41	0.34	10,414
Ravensdale	11.15	39.72	45.13	4.00	0.52	11,768
Renton	14.73	33.19	40.49	11.59	0.47	9,868
Taylor	5.6	36.0	44.0	14.4	0.94	11,550
Kittitas County						
Roslyn	3.68	34.33	48.59	13.40	0.36	12,253
Pierce County						
Carbonado	2.74	36.31	52.83	8.12	0.49	13,538
WEST VIRGINIA						
Fayette County						
Ballinger	3.7	23.0	70.8	2.47	0.59	14,590
Claremont	3.54	17.03	73.28	6.15	0.51	14,099
Derryhale	3.33	17.34	75.68	3.65	0.83	14,593
East Sewell	3.34	21.25	73.18	2.23	0.56	14,821
Layland	2.72	16.3	75.49	5.49	0.66	14,440
Glen Jean	3.7	16.0	75.2	5.1	1.15	14,310
Kilsyth	2.86	17.63	75.16	4.35	0.94	14,539
Macdonald	2.96	22.74	69.29	5.01	0.89	14,425
Minden	3.4	21.0	72.4	3.2	0.60	14,670
Prudence	3.85	19.08	72.05	5.02	0.84	14,256
Harrison County						
Clarksburg	1.98	40.54	48.40	9.08	4.20	13,466
M'Dowell County						
Ashland	2.8	14.5	77.4	5.33	0.64	14,550
Big Sandy	4.1	15.0	77.1	3.78	0.64	14,580
Coalwood	2.19	13.91	75.25	8.65	0.57	13,995
Davy	3.7	13.5	78.9	3.85	0.60	14,620
Eckman	3.3	13.5	78.0	5.17	0.59	14,480
Elkhorn	3.24	13.13	79.00	4.63	0.49	14,598
Crozer	2.74	13.94	78.38	4.94	0.59	14,645
Norfolk	3.73	14.62	78.22	3.43	0.53	14,632
Powhatan	3.3	14.5	77.7	4.49	0.55	14,630
Switchback	4.1	14.5	77.3	4.1	0.52	14,510
Vivian	2.3	12.5	80.8	4.44	0.58	14,720
Mercer County						
Goodwill	2.9	14.0	79.4	3.68	0.53	14,830
Simmons	3.8	13.5	79.4	3.34	0.80	14,670
Raleigh County						
Raleigh	3.6	15.5	76.1	4.75	0.79	14,460
Slab Fork	2.7	13.0	78.5	5.76	0.55	14,450
Tucker County						
Thomas	2.39	22.39	70.04	5.18	0.67	14,557
WYOMING						
Bighorn County						
Kirby	16.11	32.96	48.09	2.84	0.50	11,211
Carbon County						
Fort Steele	8.85	36.58	50.99	3.58	0.92	12,062
Hanna	11.45	42.58	39.33	6.64	0.38	10,890
Iron	18.41	34.50	43.38	3.71	0.28	9,130
Crook County						
Oxus	28.55	29.43	38.31	3.71	0.28	8,233
Johnson County						
Buffalo	29.05	29.07	34.67	7.21	0.39	7,627
Sheridan County						
Dietz	24.70	37.55	33.04	4.71	0.39	8,903
Monarch	22.63	35.68	37.19	4.50	0.59	9,734
Sweetwater County						
Black Buttes	18.86	29.17	47.85	4.12	0.49	10,283
Rock Springs	11.64	36.37	48.58	3.41	0.81	11,768
Superior	13.67	32.43	51.00	2.90	0.72	11,563
Bondurant	14.36	32.48	48.73	4.43	3.56	10,303

The Electrical Study Course—Characteristic Curves of Shunt and Series Generators

The effects of varying the load on a shunt and a series generator are discussed, and the external characteristic curves shown.

ELECTRIC generators and motors act in certain ways under given conditions; for example, as the current is increased in the field coil of a shunt generator, the voltage will increase in value until the iron in the polepieces becomes saturated. Beyond the saturation point the voltage remains practically constant irrespective of the value of the current in the field coils. By plotting the volts at the armature terminals against the amperes in the field coils, as explained in the lesson in the Apr. 9 issue, the result will be a curve similar to that shown in Fig. 1.

Similarly, the effect of the load on the voltage of a generator may be shown in a curve. This is done by connecting a voltmeter across the armature terminals and an ammeter in series in the circuit, as shown in Fig. 3; and after adjusting the voltage to normal, say 110 volts, put a load on the machine of, assume, 30 amperes, as indicated in Fig. 4. This, as shown in the last lesson, will cause the voltage to drop at the armature terminals: First, owing to the resistance of the armature, and second, the current in the field coils will also be slightly reduced because of the decrease in volts at the armature terminals. Assume that the volts at the armature terminals decrease 1.5, this will leave $E_a = 108.5$ volts available at the load and will give point *a* on curve *A*, Fig. 2, which is obtained by taking the 30-ampere division at the base of the curve and running up vertically until it intersects the horizontal line running out from the 108.5-volt division, as indicated by the dotted lines.

If the load is now increased to 60 amperes, the volts at the armature terminals will further decrease, say to 107; then plotting the load current of 60 amperes against the voltage at the armature terminals, 107 volts, gives point *b* on the curve. Increasing the load to 90 amperes will cause the voltage to drop accordingly, or, as shown at point *c* on the curve, to be 105.5. Now, if the load is further increased, a corresponding decrease in voltage is obtained. However, it is evident that this process cannot keep on indefinitely, because if it did, eventually a point would be reached where an infinitely large current would be obtained on an infinitely small voltage.

What actually happens in a shunt generator is that the voltage decreases as the current is increased up to a certain value and then both volts and current decrease to zero or approximately so. This is shown on the curve; when the current has increased to 241 amperes, the volts have dropped to about 55. At this point, if the resistance of the circuit is further decreased to increase the current, the voltage and current begin to decrease and come back to zero, or theoretically so. However, on account of the residual magnetism in the polepieces maintaining a small voltage at the armature terminals, the volts and current will only approximate zero.

What has just been stated regarding the shunt machine indicates that if it was short-circuited, the voltage and current would drop to zero and no harm would be done. This is true of the self-excited shunt generator, but not of the other types, as will be seen in the following:

If the field coils of the shunt machine are energized from an outside source, as in Fig. 5, then the field current will be maintained constant irrespective of the load. Consequently, the voltage generated in the armature will remain practically constant, and the volts drop at the armature terminals will be due to the armature resistance only. Therefore, the volts at the arma-

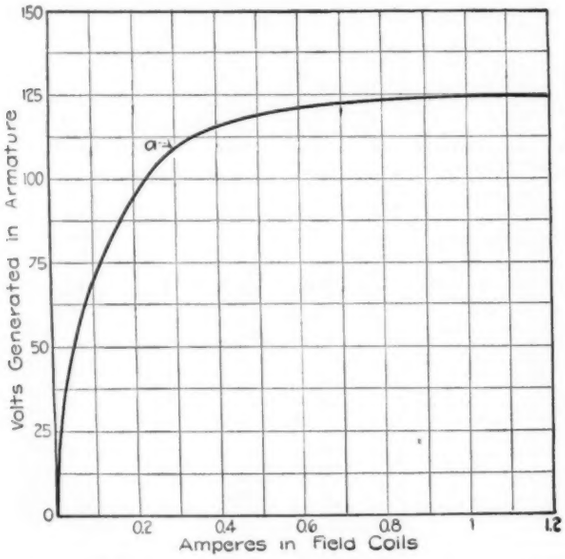


FIG. 1. DIRECT-CURRENT GENERATOR VOLTAGE CURVE

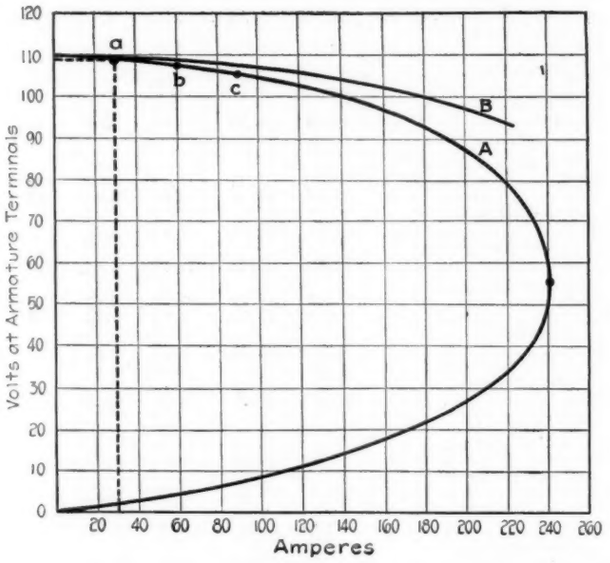
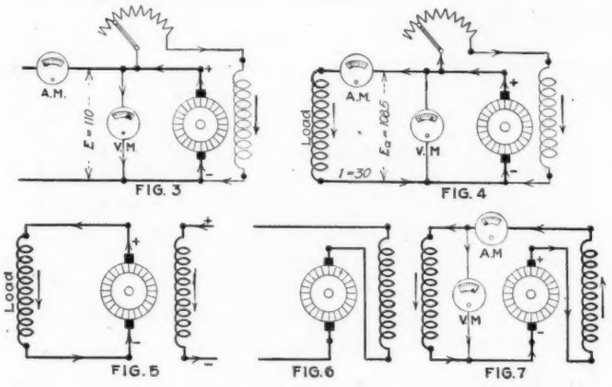


FIG. 2. LOAD-VOLTAGE CURVE OF SHUNT GENERATOR

ture terminals will not decrease so rapidly as when the field coils are connected in parallel with the armature. The resultant curve for a separate-excited shunt generator will be similar to the curve *B*, Fig. 2.

In the series-connected generator, Fig. 6, the machine cannot produce any voltage when it is disconnected from the load except that generated due to the residual magnetism in the polepieces. Consequently, at no load the



FIGS. 3 TO 7. DIAGRAMS OF SHUNT-CONNECTED AND SERIES-CONNECTED GENERATORS

voltage of a series machine is approximately zero, as against the shunt machine in which the voltage is at a maximum value at no load. By connecting a voltmeter and an ammeter to the series machine, as in Fig. 7, and taking readings for different loads, a curve will be obtained as in Fig. 8. It will be seen that the shape of the curve from zero to point *a* approximates the shape of the saturation curve, Fig. 1, from zero to point *a*.

The series generator as its voltage builds up with the load has not only to produce pressure to cause the current to flow through the external circuit, but also through the armature and field windings. The volts drop in the armature and field windings varies as the product of the current in amperes and the resistance of the windings in ohms. However, the total voltage generated in the armature winding does not increase as the current in the field winding. Referring to Fig. 1, it will be seen that up to point *a* on the curve, the increase in volts is quite rapid as the field current is increased, but beyond this point the increase is very slow, being practically zero at the upper end of the curve. It is this latter fact that makes the voltage of the series generator decrease above a certain load.

In Fig. 8 the first 20-ampere load energizes the field coils to the extent that 50 volts is generated at the armature terminal. When the load is increased to 40 amperes, the volts only increase to about 73 and at 60 amperes about 91 volts, until at 130 amperes, the maximum, or 114 volts, is developed at the armature terminals. From this it is seen that the volts at the armature terminals increase rapidly at first, but that the increase becomes less for a given number of amperes increase until an increase in load does not cause the volts to become greater but less, as in this case, when the load is made higher than 130 amperes.

Now, if we assume the resistance of the armature and field windings to be 0.2 ohm, then with a 20-ampere load on the machine the volts drop will equal amperes $\times$ ohms, or $20 \times 0.2 = 4$ volts; that is, the armature is actually generating 54 volts when supplying 20 amperes to the external circuit, but 4 volts is used up to cause the current to flow through the armature and field windings; therefore, only 50 volts is available at the armature terminal. At a 60-ampere load the volts drop in the armature is $60 \times 0.2 = 12$ volts. Hence, the armature is generating a total voltage at this load of $91 + 12 = 103$ volts. When the load has increased to 130 amperes, the volts drop in the armature is $130 \times 0.2 = 26$ volts, and there is generated $114 + 26 = 140$ volts. However, 26 volts is used up in the machine's windings, consequently only 114 is available at the armature terminals. Assume that the load is increased from 130 to 180 amperes. Then, the drop in the armature will be $180 \times 0.2 = 36$ volts. Further assume that this increase of load only causes the total voltage to increase to 143.5. Then, the available volts at the armature terminals is $143.5 - 36 = 107.5$. Hence, it is seen that the increased volts generated in the armature due to the increased load is not enough to compensate for the increased drop in the windings, and the available volts decrease with an increase in load. Hence, it is evident that the volts at the armature terminals on a series generator will increase in value with an increase in load until the iron in the magnetic circuit is near saturation; beyond this point the volts begin to decrease with an increase of load.

The curves, Figs. 2 and 8, are sometimes referred to as external characteristic curves of the generator, from the fact that they are plotted from conditions existing outside the machine. If the voltage values existing in the armature windings were used in the curves, we would have to add the volts drop in the armature at

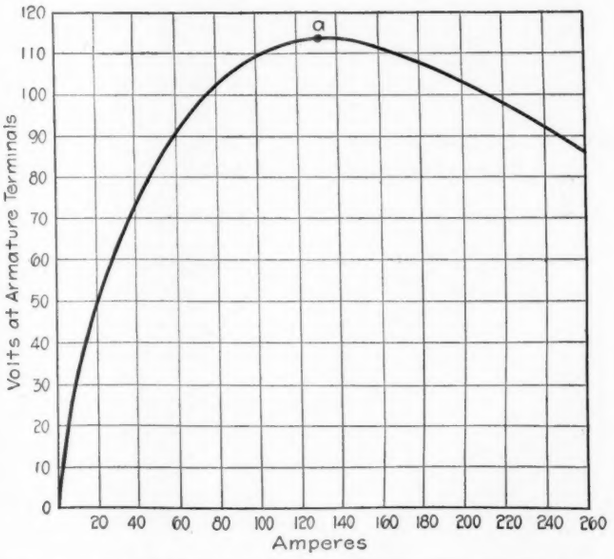


FIG. 8. LOAD-VOLTAGE CURVE OF SERIES GENERATOR

the different loads to the voltage at the brushes corresponding to these loads, which would have given a higher pressure than that indicated on the curves in the figures. A load-voltage curve plotted by using the total voltage generated in the armature instead of that at the brushes is called an internal-characteristic curve.

The problem given in the last lesson was: "In transmitting 540 amperes over a circuit 425 ft. long one way, there is a drop of 16.5 volts in the line. How large are

the conductors in cross-section? How much will the conductors have to be increased in size to reduce the line drop to 10 volts?"

The size of the conductors is obtained by the formula,

$$Cir.mils = \frac{21.7DI}{E_d} = \frac{21.4 \times 425 \times 540}{16.4} = 299{,}469$$

which is approximately a 300,000-cir.mil conductor. The size of a conductor that would cause only a 10-volt drop under the foregoing conditions can also be determined by the circular-mil formula, or in this case,

$$Cir.mils = \frac{21.4 \times 425 \times 540}{10} = 497{,}130$$

or approximately 500,000 cir.mils. Then the size of the conductor would have to be increased 500,000 — 300,000 = 200,000 cir.mils.

A voltmeter has 12,000 ohms resistance, and when connected to two points of a circuit reads 36 volts. Find the current taken by the instrument. If 3.6 amperes is passing through the section of the circuit that the instrument is connected across, find the resistance of the section.

If the resistance of a voltmeter is 15,000 ohms and when connected across a given circuit 0.01 ampere flows through it, does the instrument indicate the correct voltage of the circuit if the needle points to 140 on the scale?

Dry Crown-Sheet Firebox Boiler

By S. P. Black

The illustrations show a type of boiler that most readers would say was unfeasible if they were asked their opinion as to utility and safety without previous knowledge that hundreds of these boilers have been used for years with no disastrous results. I remember being in one of the large boiler shops of the Middle West when the specifications for one of these boilers came in and figures were asked regarding its construction. Our opinion at that time was that whoever knew no better than to design such a boiler, expecting it to work in safety, needed a guardian and that would be putting it mildly.

An examination of Fig. 2 would at first suggest that the design is a contradiction of all known boiler rules in the deliberate use of a dry crown-sheet, one that is not covered by water; for it may be observed that the water-leg, a 6-in. space, is continued completely under the wagon top, and that the water level scarcely reaches within 18 in. of the top of the boiler as would be indicated by Fig. 2.

We are all forced to alter our preconceived opinions somewhat at times, and after finding this type of boiler in use and watching it under operation, I have gotten rid of a pre-established prejudice and dislike, as I have known them to be operating under severe conditions for about fifteen years.

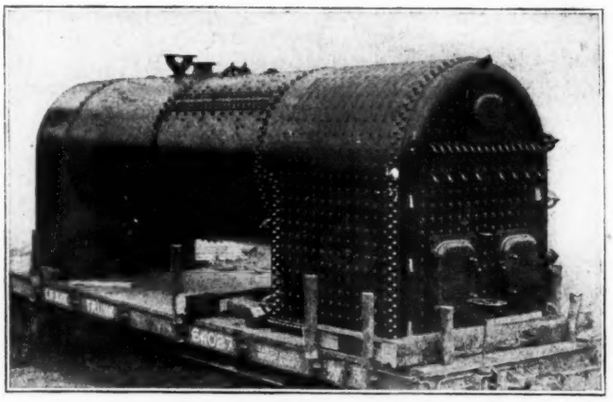


FIG. 1. EXTERIOR OF DRY CROWN-SHEET BOILER

Most of us can remember the popular fallacy and general belief not long since prevalent of red-hot crown-sheet, low water, turning on the feed and an explosion from sudden generation of steam. We used to believe that cold water on a red-hot crown-sheet would generate sufficient steam to cause an explosion, but experiments have proved the contrary and have shown that it was a difficult matter to bring about an explosion under such conditions.

In the boiler shown in Fig. 1, although it was not designed to be foolproof and even though the crown-sheet is at all times bare of water and entirely dry, such a thing as burning the crown-sheet has never occurred to my knowledge. Furthermore, this type of boiler is one that has the reputation of being impossible to burn, low water not affecting it until the water gets below the arch tube and exposes the upper portion thereof, at which time the tubes will blow out. This boiler was designed for 175 lb. pressure, a fairly high pressure for this type of boiler.

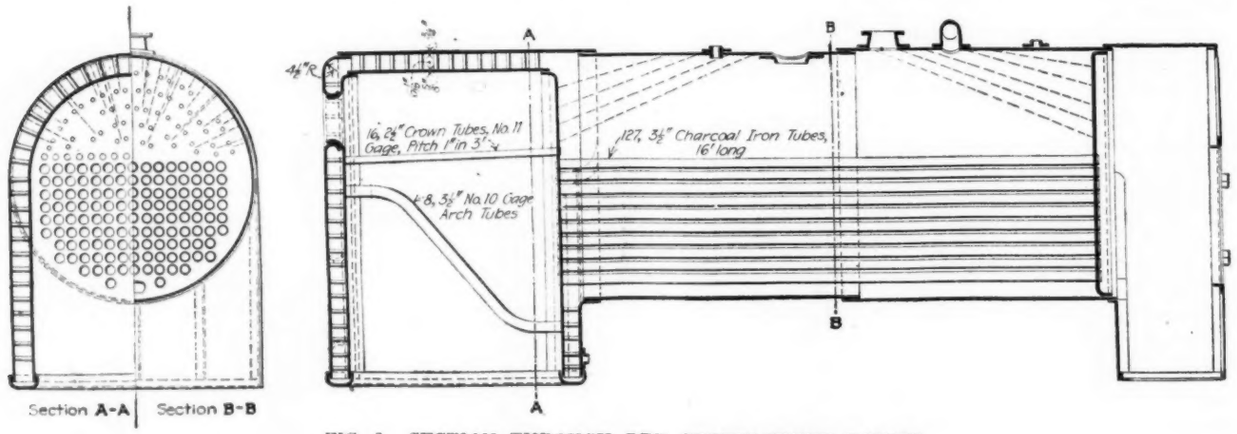


FIG. 2. SECTION THROUGH DRY CROWN-SHEET BOILER

Supporting Effect of Boiler Heads

BY NEIL M. MACDONALD

Should the strength of the unsupported head be added to the strength of the stays to find the allowable pressure in a boiler? The author answers the question in the negative.

THE tendency of modern engineering practice is toward larger boiler units and high pressures. This tendency makes it imperative that serious consideration be given to the bracing and stay-bolting of the boiler surfaces. A number of engineers contend, no doubt without giving the subject proper consideration, that the strength of the braces or stay-bolts should be added to the strength of the sheet which they presumably support, and that the sum of these two values should be taken as the strength of that portion of the boiler. At first sight this theory may appear logical, but careful consideration clearly illustrates the fallacy of the contention.

There are four boiler surfaces which will be considered one by one, to indicate wherein the foregoing method of figuring is erroneous. The first case is the braced portions of the heads of a horizontal return-tubular boiler and particularly that portion above the tubes. Assume, by way of illustration, a 72-in. by 18-ft. horizontal-tubular boiler having a distance of 26 in. between the top of the tubes and the shell plate. The area to be braced in this case is the area of a segment inclosed by lines drawn 3 in. from the shell and 2 in. from the tubes, or an area of 936 sq.in.

First find the strength of the unbraced flat head. There is no authentic formula for figuring accurately the strength of an unbraced flat head, and what is known of the subject is based on theory combined with a few practical experiments. However, as absolutely accurate results are not essential for the purpose of this discussion, the strength of the unstayed head will be calculated in accordance with Nichols' formula, which is based on his experiments and is

$$P = \frac{T \times S \times C}{A \times F}$$

in which

P = Safe working pressure, in pounds per square inch;

T = Thickness of plate, in inches;

S = Tensile strength of plate, in pounds per square inch;

C = Constant = 10;

A = Area to be stayed, in square inches;

F = Factor of safety = 8.

Assuming that the boiler head is ½-in. thick and that the material has a tensile strength of 55,000 lb. per sq.in., and substituting these values in the formula,

$$P = \frac{\frac{1}{2} \times 55{,}000 \times 10}{936 \times 8} = 37 \text{ lb. per sq.in. nearly}$$

The bursting pressure is, then, 37 × 8 = 296 lb. per sq.in.

Now, in accordance with the foregoing erroneous theory, if the boiler was to be designed for a safe working pressure of 125 lb. per sq.in., it would only be necessary to add bracing good for 125 − 37 = 88 lb., or the difference between the strength of the unbraced head and the strength required. Following this theory, if the factor of safety on the unbraced head was 8 and on the braces 6, the bursting pressure of the braced head would be 37 × 8 + 88 × 6 = 824 lb. per sq.in. This is absolutely wrong, and the attempt will be made to prove, by illustration, that the real bursting pressure of the head is only the value of the strongest portion, which in this case is the braces, and is 88 × 6 = 528 lb. per sq.in. The safe working pressure is the bursting pressure divided by the factor of safety, or 528 ÷ 6 = 88 lb. per square inch.

To illustrate the fallacy of the theory, assume a solid stone wall capable of withstanding a pull of 1000 lb., and a second solid stone wall directly oposite the first one, able to withstand any pull up to 296 lb. It is assumed that these walls are so constructed that if a pull of 296 lb. is applied to the stronger wall, it will not be affected, but if the same pull is applied to the weaker wall, it will collapse.

Now, join the two walls by a rope, fastened so that it cannot slip, and capable of standing any pull up to 528 lb. Apply a pressure between the two walls tending to push them apart and strain the rope. Let the pressure start at one pound and increase gradually, and then analyze the behavior of the two walls and the connecting rope. The pressure rises slowly until 296 lb. is reached, which is greater than the weaker wall can stand, and if it were not for the rope holding it up, the wall would collapse; but there is no perceptible change in conditions, as both walls still stand and the rope is still intact. When the pressure reaches 528 lb., which is the ultimate strength of the rope, the rope breaks, allowing the full load of 528 lb. to come on the weaker wall. As the latter can stand only 296 lb., both the rope and the wall must necessarily let go. It is therefore obvious that the addition of the strength of the weaker wall did not add to the strength of the rope, and the strength of the wall and rope combined was only that of the stronger member, or the strength of the rope.

Now substitute the assumed boiler for the walls and the rope. The stronger wall is equivalent to the shell of the boiler to which the pad ends of the diagonal braces are attached, the weaker wall is equivalent to the head of the boiler to be braced, and the rope is equivalent to the braces.

The boiler head is supposedly designed to burst at 824 lb. The unbraced head will burst at 296 lb., and the bracing has an ultimate value of 528 lb., and by adding the strength of the unbraced head to the strength of the braces, the result is a bursting pressure on the braced head of supposedly 824 lb. Following the same line of reasoning as was used with the stone walls and the rope, as soon as a pressure equal to the value of the braces is applied, the head will give way. That is to say, when a pressure of 296 lb. has been reached, the value of the unbraced head is gone, and when a pressure of 528 lb. has been reached, the braces give way, carrying the head with them. It therefore follows that the assumed boiler is designed to burst at 528 lb. and not 824

lb. as it was supposed to be. This is based on the strength of the braces, and dividing the bursting pressure of 528 lb. by the factor of safety of 6, it is found that the boiler is designed for a safe working pressure on the heads of 88 lb. and not 125 lb. To make the heads safe for 125 lb. working pressure, they would have to be braced for 125 lb. and the value of the unbraced head ignored.

The same argument applies to the stay-bolted furnace sheet of a vertical-tubular boiler, with a slight difference when the furnace sheet proper is stronger than the stay-bolts. In the latter case it is not permissible to figure the safe strength of the furnace and then add that of the stay-bolts and consider the sum as the desired working pressure. Assume, for instance, that the actual collapsing pressure of a cylindrical furnace is 625 lb. and that an actual collapsing pressure of 1075 lb. is desired and that stay-bolts to the value of 1075 — 625 = 450 lb. are installed to bring the actual collapsing strength of the furnace up to the desired pressure. Comparing this with the stone-wall illustration, the furnace is equivalent to the weaker wall and the stay-bolts are equivalent to the rope. When a pressure of 450 lb. is applied, there will be no perceptible change in conditions, as the walls can withstand that pressure; but when the load reaches 625 lb., the weaker wall starts to collapse, transferring the load to the rope, which is good for only 450 lb.; therefore, the wall and the rope give way. So it is obvious that the strength of the stay-bolts cannot be added to the strength of the furnace sheet and the sum considered as the strength of the stay-bolted furnace. If the example just given is reduced to safe working pressures by dividing each item by a factor of safety of, say, 6, the unstayed furnace will have a safe collapsing pressure of 104 lb. and the stay-bolts alone will be safe for 75 lb., making the stay-bolted furnace good for only 104 lb. If a safe working pressure of 200 lb. is desired, the furnace must either be strong enough in itself for 200 lb. or else the stay-bolts must be good for 200 lb. It is incorrect to add them together and call the combined value the safe working pressure.

The same argument applies to the stay-bolting of a cone top in a submerged vertical-tubular boiler and to the flat firebox sides of a locomotive-type boiler.

Summing up the entire subject, a braced or stay-bolted portion of a boiler is no stronger than its strongest part, and on no account should the strength of the braces or stay-bolts be added to the strength of the plate and their sum considered the strength of that portion of the boiler.

Some Notes on Turbine Bearings and Their Lubrication

COMPILED BY CHARLES H. BROMLEY

The data given in this article are from the author's loose-leaf notebook and have been gathered from many sources during recent years. Some engineers may desire them for their notebooks.

IT IS the consensus of opinion that the coefficient of friction slightly decreases with increasing speed. In high-speed bearings the coefficient is independent of the load.

Bearing Pressure—With slow-running bearings the pressure per square inch usually is not more than 70 to 80 lb., with white metal and forced lubrication. Bauer, Lascher & Swallow give 57 to 114 lb. per sq.in. for forced lubrication.

Temperature of the Oil—About 165 deg. F. should be considered the limit for turbine bearings, although constant temperature of 195 deg. F. may not give trouble, but the safety margin is cut down. When the oil reaches a temperature above 160 deg., it is likely that it will carbonize, therefore, 120 to 140 deg. is good practice; 250 deg. F. is the limit at which most oils have enough viscosity to be of any value in turbine lubrication.

Influence of Viscosity.—Pressure in bearings experimented on by Tower was 625 lb. due to oil being dragged in by the journal; that is, dragged in between the journal and the bearing. This teaches, of course, that the oil should be fed into the bearing at a point where the pressure is lowest.

Value of Viscosity—It is well to cite that in stern tubes of torpedo-boat destroyers, where water is the lubricant used, mean bearing pressure is limited to 20 to 25 lb. per sq.in. of projected area. Railway axles using grease go as high as 600 lb. per sq.in. of projected area.

Viscosity must be such that the oil film is carried completely around the journal without breaking down and without squeezing out of the bearing.

Stability of Oil Film—A remarkable demonstration of the stability of an oil film is shown by tests of the Westinghouse Co. (Pittsburgh) on segmental thrust blocks of a Kingsbury bearing, where with a mean surface speed of 54 ft. per sec. pressure could be (and was) increased to 10,000 lb. per sq.in. before failure occurred; but it was the white-metal facing of the bearings that flowed and not the oil film that broke down, as no serious heating of the oil took place.

Relative Position of Lubricated Surfaces—In high-speed lubrication the journal is never concentric with its bearings. This is the ideal condition, as the experiments of Osborne Reynolds and others have shown that opposing surfaces must never be parallel to each other for successful lubrication.

Specific Heat of Oil—In practice, the specific heat is usually taken as 0.31 and the specific gravity as 0.88. Battle's "Lubricating Engineers' Handbook," page 138, gives the specific heat of petroleum lubricating oil at 60 deg. as 0.4175.

The Coefficient of Friction—The coefficient of friction, or ratio of the resistance of the oil film to the load may vary, according to Stoney, from 0.0008 to 0.003, but he suggests 0.002 as suitable for usual cases where the unit pressure is about 500 lb. per sq.in.

Oil Consumption and Costs—Returns from a large number of users of Westinghouse turbines show that only about one-quarter gallon of oil is required for the bearings per kilowatt per year—"Steam Turbines," by L. G. French, p. 7. H. G. Scott in a paper read before the American Institute of Electrical Engineers, January, gave the lubrication charges per kilowatt-hour of reciprocating engines as 1.77c. and of the turbines as 0.35c. This was back in 1896, when turbines were of small capacity, comparatively.

Cooling Bearings with Water—At the plant of the Buffalo General Electric Co., Buffalo, N. Y., water is supplied from the boiler-water makeup evaporators, which are 60 ft. above the turbine floor and receive their supply from the hotwell pumps. From here the pipes are led to the turbine bearing, giving a head of 60 ft.; therefore, no extra pumps are used to handle the water which cools the turbine bearing.

Surface Speed—Land, 30 to 60 ft. per sec.; marine, 15 to 30 ft. per sec.

Ratio of Length to Diameter—Land, 2 to 3:1; marine 1:1 to 2:1.

Parsons Elastic Sleeve Bearings—For turbines with speeds of 3000 to 4000 r.p.m. Parsons uses an elastic sleeve bearing, consisting of concentric sleeves slipped endwise over the shaft. Instead of the top and bottom brasses, the concentric sleeves are used. The clearance between one sleeve and another varies from 0.002 to 0.006 in. The inner sleeve is really the bearing brass and is flanged at one end and has a ring nut at the other. The inner sleeve is thus fixed loosely in the bearing block; the other sleeves, usually two, are slipped on over the inner one, which has oil grooves and radial holes to let oil get to the other sleeve, which also has small holes in it to let the oil through. The bearing forms a hydraulic cushion which admirably stands vibration. This type of bearing should eliminate bearing trouble where chronic vibration of the machine causes a hot bearing, as may happen when severe vibration is caused by an unbalanced rotor. A similar bearing is used on Westinghouse turbines of speeds around 3600 r.p.m.

High-Speed Zoelly Machine—The high-speed Zoelly machines use a spherical bearing in which a sleeve fits over the journal, the sleeve being held in by segments resting upon spherical-headed screws.

Oil Consumption and Bearing Pressures—For high-speed bearings B. C. K. Balfrey, in a paper on "High Speed Bearings," Proceedings of the Rugby Engineering Society, Vol. 10, 1912-13, gives the practice of three English makers as:

Gal. per Sq.In. per Min.	Pressure Lb. per Sq.In.
0.05	45 to 60
0.05	5 to 10
0.01	.....

Heat Loss at Turbine Bearings—The loss of heat in the bearings of well-lubricated turbines of large output is less than 1 per cent., reckoned on the total available heat.

Thrust-Bearing Clearances—Thrust bearings of the ring and collar types usually have clearance between rings and collars of from 0.002 to 0.003 inch.

Influence of Temperature on Chemical Reactions—Broadly, the higher the temperature the more rapid the chemical reaction between the constituents of the oil. At 120 deg. F., common in turbine work, chemical reactions go on, though slowly when pure mineral oil is used. The most common trouble is that caused by paraffin separating out of the oil in the form of a pasty, jelly-like substance adhering to the cooling coils of the oil cooler, greatly decreasing the rate of heat transmission through the coils. This trouble is most noticeable with oils of high viscosity, says the Westinghouse Co. An olefine-base oil avoids this trouble; but the cost is high. Russian oils are of olefine base.

Heat Transmission in Oil Coolers—The following data are from tests by M. Boella, of the Italian Corps of Naval Architects, and were given by him in an article in *Rivista Marittima*.

Explanation of types of oil coolers:

A: Cylindrical shell with two rows of U-tubes; water passing in series through tubes; oil surrounding tubes entering at bottom of shell, discharging at top; single pass, no baffles; gravity oil circulation.

B: Horizontal shell; straight tubes; water in single pass through tubes; oil surrounding tubes; three passes; counter-current.

C: Horizontal cylindrical shell; oil through helical coils, one coil inside the other (not one pipe inside another), oil inlet to inside coil returning through outside coil; water in one pass through shell.

D: Condenser type; straight horizontal tubes; oil, two passes; water, two passes; oil and water flow in same direction, that is, bottom to top.

E: Cylindrical vertical shell; short flattened tubes; oil through tubes in one pass, inlet at top, outlet at bottom; water, single pass, inlet bottom, outlet top.

Types of Oil Coolers	Weight, Lb.	Diameter, In.	Height or Length, In.	Space Taken Up, Cu.Ft.	Cooling Surface, Sq.Ft.	Weight per Sq.Ft.	Space Taken Up per Sq.Ft., Cu.Ft.	Coefficient of Trananission per Sq.Ft. per Degree Difference in Temperature B.t.u.
A	772	31.5	39.4	17.7	28.00	27.6	0.63	33 to 59
B	1,234	13.8	110.3	9.5	484.00	2.56	0.02	.....
C	992	15.7	118.1	13.4	215.00	4.61	0.063	66 to 73
D	1,543	23.6	66.9	17.0	204.52	7.54	0.084	25 to 35
E	265	12.6	15.7	2.3	62.00	4.26	0.038	136 to 180

Note that the cooler E gives high heat transfer coefficient with small weight and volume.

In a paper, "Performance of Lubricating Oil Coolers," by M. C. Stuart, in the May 17 *Journal* of the American Society of Naval Engineers, some interesting results of tests were reported on three types of oil coolers, here designated A, B and C.

A: Plain tube; oil in shell in multipass arrangement; water through tubes in single pass.

B: Plain tubes, fitted with retarders; oil through the tubes in multipass arrangement; water in shell in multipass arrangement.

C: Special corrugated concentric tubes; oil between tubes in single pass; water in shell in single pass.

The coolers used were of practically the same weight and volume.

A summary of the tests follows:

Cooler	A	B	C
Heat transfer coefficient (based on unit surface) at equal capacities, B.t.u. per hr. per sq.ft. per deg. mean temperature difference	82.00	39.00	125.00
Relative heat transferred (based on unit volume) at equal capacities, B.t.u	1,000.00	450.00	450.00
Capacities, based on equal temperature drops, lb. oil per min.	195.00	85.00	27.00
Oil-friction drop, based on equal capacities, lb. per sq.in. (pressure)	7.80	2.00	22.6
Weight per square foot of surface, lb	10.87	7.95	39.00
Volume per square foot of surface, cu.ft	0.49	0.53	0.15

These tests showed that the relative friction drops are in the same order as the relative heat-transfer factors and furthermore that the weights per square foot of cooling surface are in the order of the heat-transfer factors.

The summary strikingly shows that when considering the relative merits of oil coolers, all features of design should be taken into account.

Separating Water from Oil—The oil from the bearings may be heated for a considerable time to a temperature of 200 deg. F. without impairing the quality of the oil, when separating water from oil.

Testing Oil for Water—The following method is in use by some engineers of the United States Navy. Draw a small quantity of oil to be tested into an ordinary test tube; mix with the oil an equal quantity of gasoline and shake the contents of the test tube. The water will settle to the bottom. With a graduated tube the percentage of water may be determined, the quantity of oil and gasoline being known.

The Michell Thrust Bearing—The bearing surface is made up of adjustable segments, each pivoted to automatically produce a pressure oil film between the collar and bearing surface. The body of the bearing forms the oil well, and in large-sized bearings is water cooled. The coefficient of friction is about 0.0015 as against 0.03; the factor of safety at 300 lb. pressure per square inch, projected area is greater than multi-collar bearings give at 50 lb. per square inch. The friction is about one twenty-fifth that in multi-collar bearings.

The Michell Journal Bearing—This bearing for large sizes has 12 segments forming the bearing surface. Each segment is faced with white metal and rests in a spherical seat. The body of the bearing forms an oil well, the oil passing to the journal through holes, admitting oil between each segment at their seats. The following table gives the results of tests of experimental Michell journal bearing conducted by Cammell, Laird & Co., Birkenhead, England:

TEST OF EXPERIMENTAL MICHELL JOURNAL BEARING

Duration of Test, Min.	Total Load, Lb.	Bearing Pressure, Lb. per Sq.In.	Revs. per Min.	Surface Speed, Ft. per Min.	Amperes	Volts	Horsepower Input	Oil Supply: Final Inlet Temp., Deg. F.	Oil Supply: Final Outlet Temp., Deg. F.	Oil Supply: Rise of Temp., Deg. F.	Oil Supply: Flow of Oil, Lb. Min.	Friction Horsepower from Heat to Oil	Coefficient of Friction	Actual Friction, Lb.
45	.....	...	585	1,84C	'€.5	406	9.2	68	84	16	12.6	1.9	.....	....
105	2,400	145	620	1,95&	14.5	403	7.9	79	99	20	14.8	2.8	0.0099	47.5
105	3,600	220	615	1,930	16.0	395	8.6	84	101	17	14.3	2.3	0.0054	39.2
60	4,800	290	605	1,900	16.6	382	8.6	83	100	17	15.6	2.5	0.0045	43.7
40	6,000	370	615	1,930	16.9	395	9.1	84	102	18	17.6	3.0	0.0043	51.6
75	7,300	440	607	1,907	18.9	391	10.0	84	102	18	18.7	3.2	0.0038	55.4
45	8,500	520	605	1,900	19.0	395	10.2	83	99	16	19.0	2.9	0.0029	50.1
60	9,800	600	618	1,940	20.4	395	10.9	71	93	22	19.0	4.0	0.0034	67.6
90	11,700	700	611	1,920	21.0	391	11.1	76	100	24	19.7	4.5	0.0033	77.2
30	14,800	900	620	1,950	26.5	400	14.4	77	102	25	22.7	5.4	0.0031	91.7
30	.....	...	1,315	4,130	23.0	390	12.2	76	95	19	23.0	4.1	.....	....
60	2,400	145	1,320	4,140	27.8	392	14.8	74	96	22	26.4	5.5	0.0091	43.7
45	5,500	330	1,320	4,140	29.8	390	15.8	77	104	27	25.2	6.4	0.0046	51.1
60	8,500	520	1,303	4,100	40.0	398	21.6	82	117	35	33.0	10.9	0.0051	87.5
60	11,700	700	1,324	4,140	50.0	382	26.0	76	111	35	37.3	12.2	0.0042	98.3
105	11,700	700	1,317	4,140	42.0	390	21.2	73	112	39	31.2	11.5	0.0039	91.2
30	14,800	900	1,320	4,140	45.5	400	24.7	76	117	41	33.0	12.7	0.0034	100.4

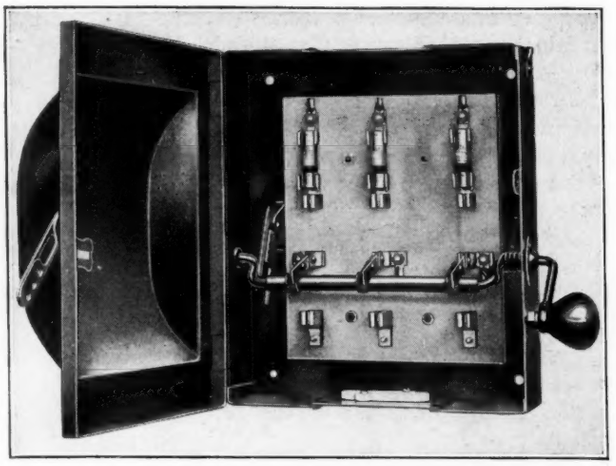
Westinghouse Thrust Bearings—The segmental thrust bearings have red-metal packing rings; the effective bearing surface is, roughly, 55 per cent. on the thrust or outer side and 45 per cent. on the inner side. The 45,000-kw. two-cylinder compound turbine at Providence, R. I., has effective bearing surface of 69 sq. in., thrust side, 54.5 sq.in., back. The maximum bearing speed at 1800 r.p.m. is 100 ft. per second.

Data on this subject are meager and widely scattered, and a really satisfactory compilation is yet to be presented.

Square D Motor-Starting Switches

The illustration shows a steel-inclosed starting switch made for three-phase motors of 5 hp. capacity or less. It was designed by the Square D Co., of Detroit, to afford protection against accidental contact with live parts, to protect the operator from being burned by the flash while operating the switch and to prevent tampering with circuits.

The switch is of the double-throw knife-blade type



MOTOR-STARTING SWITCH WITH COVER OPEN

with the running side arranged for fuses. It is completely inclosed in a metal box provided with a hinged cover.

The switch is operated by a handle on the outside of the box, name-plates on the cover designating the position of the switch. Means are provided to lock the cover shut to prevent unauthorized persons from overfusing the switch or in any way tampering with the connections. A safety lock for the handle is also provided to prevent the careless closing of the switch when anyone is working on the line or the equipment controlled by the switch. Inside the cabinet a steel latch prevents throwing the switch from the off to the running position without its first being thrown into the starting position. The latch also makes necessary a quick change from starting to running position. The switch can be furnished with either straight-induction or star-delta connections. With the latter a separate main-line switch must be installed ahead of the starting switch in accordance with the regulations of the National Electrical Code.

Why Bill Reads "Power"

BY HIMSELF

The whistle had sounded, the day's work was done,
And engine and boiler had ended their run,
And fireman Bill, with the place spick and span,
Was waiting to hear from the blooming night man.
While watching and waiting, to kill a half-hour,
From out of the refuse he dug an old *Power*.

Then, seating himself in his rickety chair,
He studied the pages with painstaking care.
One article told how to pack a feed pump.
"That's rotten!" said Bill. "Gee! That fellow's a chump!"
But his brow quickly cleared, and he quit looking sour,
As he muttered, "By gum! I'll write something for *Power*."

Bill wrote out his letter—some job for a toiler—
As hard on religion as firing a boiler.
He told just how tight they should set up the glands,
And how to pack steam ends and not burn their hands.
"What's doing?" inquired his wife, with a glower.
"Oh, nothing," said Bill. "I'm just writing to *Power*."

Now, after the letter was well on its way,
Poor Bill recalled things he'd forgotten to say,
And after he'd waited in vain for reply,
Bill almost forgot it, as time scurried by.
But one night his wife, with her hands deep in flour,
Said, "Bill, there's a letter. I think it's from *Power*."

Bill tore off the end, and his hardened hands shook,
For what it contained made his wife stop and look—
Just a long yellow slip, very classy and nifty,
Telling someone to hand Bill the sum of two-fifty.
"Eureka!" yelled Bill. "That's as good as a dower,
For it gives me the chance for subscribing for *Power*."

Said Bill, "I'll invest it in reading, by heck!"
So back to New York went the long yellow check,
And when, at the end of a twelve-month or more,
Bill's wages were raised, Mrs. Bill wasn't sore.
"Good fortune," she said, "came to us in a shower
Not long after Bill started in to read *Power*."

Bill climbed some, for now he's the boss of the shift
And always on hand when the boys need a lift;
He knows when the engine is wasting her steam,
Can scrape in a bearing or calk a bad seam.
He's the friend of the men, and the Super's right bower,
But he isn't self-made—he's a man made by *Power*.

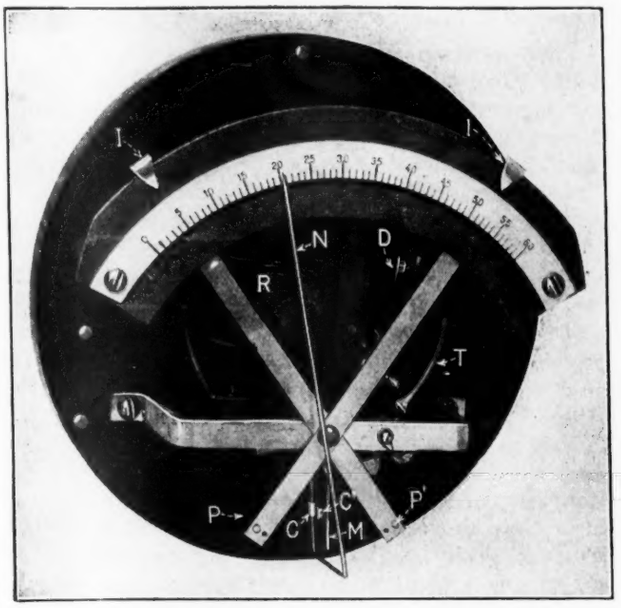
Pressure Governor for Gas and Liquid Systems

The General Electric Co. has developed a new pressure governor to control standard self-starters for motor-operated pumps and compressors for maintaining air, gases or liquids under pressure. The governor maintains a pressure between predetermined limits on any gas or liquid system that will not corrode the Bourdon tube. This governor can be used on any standard alternating- or direct-current circuit. It is rated for pressures of 80, 100, 160, 300, or 500 lb. and operates within settings of from 3 to 12 lb. between high and low pressures. Governors for higher pressures can be supplied if desired.

The governor consists of a Bourdon tube, an indicating needle, a graduated pressure scale, adjustable high- and low-pressure stops to determine the desired pressure range and a relay which actuates the contacts in the control circuit of the self-starter, all inclosed within a dustproof case, easily opened for inspection.

Action of the governor is dependent on the Bourdon tube, which should be connected to an independent discharge pipe from the pressure tank. The free end of the tube T in the figure is mechanically connected to the indicator needle N, moving it over the scale as changes of pressure affect the tube. After the settings for the pressure range have been made, the governor will automatically maintain pressure within those limits. The operation of the pressure governor is as follows:

Assuming that the pressure is at the low value, as indicated by the left-hand indicator I, then contact C on needle N completes the circuits through contact C' on movable arm M, which at the low-pressure point rests against stop P'. When this contact is made, the circuit is completed through the relay coil R, causing its armature to close. Attached to this armature is contact



PRESSURE GOVERNOR WITH COVER REMOVED

D, which upon closing, completes the control circuit to the self-starter, causing the motor to start. The armature is also attached to a spring which holds contact C' firmly against C until the contact is broken at P.

As the pressure increases, the needle pointer moves to the right, but its lower part, to which contact C is attached, moves to the left and is followed by the movable arm M. When the high-pressure point is reached, the movable arm is prevented from traveling farther by stop P and the needle continues its course, breaking the circuit by separating contacts C and C'. The instant the circuit is broken, relay R is deënergized and its armature falls, releasing the tension of the latter's spring, and because the movable arm M is counterweighted, it returns to stop post P'.

When the pressure has decreased to the minimum value contact C again completes the relay-coil circuit by engaging contact C' and the cycle of operation is repeated. The case is tapped and drilled at the bottom for the pressure-pipe and electrical-conduit connections.

Every dollar put into the Red Cross make not only for victory, but for everlasting peace between the great nations now fighting together in this war.

As It Is in Holland

BY Y. BROUWERS*

When the postman brings the paper on Saturday evening, the mistress eagerly scans it to see what is to be had from the grocer, the butcher, the milkman, etc., for we are rationed in every way. One of the most urgent questions at present is, "What shall we eat and drink and what shall we burn?" Our national mines do not supply what coal the country needs, so we depend upon importation from Germany and England. However, the Germans themselves are in want of coal because they cannot spare men enough for the mines, and this is also the case in England I suppose. Notwithstanding that, our Eastern neighbors are willing to furnish us with a limited quantity if we pay handsomely and provide the necessary facilities. So the last contract contains the conditions that we have to pay for each wagon load of about 20,000 lb. 450 guilders ($180) and have, moreover, to furnish for every wagon load a credit to Germany of a like amount. Before the war the price for the same quantity was about $40. The import from England is hampered by the want of ship capacity, and communication is dangerous on account of mines and submarines. Hence the greatest economy is necessary, for not only in the industries but also for private use coal is rationed. The industries that are most indispensable to our commonwealth, among them the factories that produce foodstuffs, receive a sufficiency. On the other hand, many factories have been forced to suspend operation of late owing to want of coal.

It is not to be wondered that many ways have been proposed and some adopted to diminish coal consumption. One of these was to limit railway traffic and not to heat the railway cars. It is only on very cold days that cars have been heated. It was proposed by an engineer in a paper at the confederation of dairy producers to replace all steam pumps in cheese and butter factories by belt-driven pumps, keeping the steam pumps in reserve, estimating that the relative steam consumption would only be about 1 to 8. He claimed that the saving would be about 6 million pounds of coal a year.

A similar case of economizing was discussed in our engineering journal *De Ingenieur* in regard to auxiliary engines on board ships. As a rule small condensing engines, consuming about 22 lb. of steam per indicated horsepower are used. One of the members of the Royal Institute of Engineers proposed to apply more economical engines; for instance, a small vertical steam engine of the uniflow type such as has been constructed by one of the professors at the Technical University at Delft, which consumes, when working condensing, only 7½ lb. of steam. Another engineer argues in a following number of *De Ingenieur* that, strange though it may seem, it is more economical to use a less economical noncondensing engine because the waste steam is used to heat the feed water and is almost always insufficient even for that purpose.

He calculates as follows, assuming that only the main engine and circulating pump engine are in operation: Assume that the circulating pump is driven by an engine using 45 lb. of steam per indicated horsepower. Steam consumption of the main engine, 3750 i.hp. × 12 lb. = 45,000 lb. per hour; circulating engine, 40 i.hp. × 45 lb. steam = 1800 lb. per hour; total boiler feed water = 46,800 lb. per hour; temperature of hotwell, 104 deg. F. Assuming that the exhaust steam from the circulating engine still contains 970.4 B.t.u. per lb. then it will give to the feed water 970.4 × 1800 = 1,746,720 ÷ 46,800 = 37.3 deg. F. rise in temperature of the total amount of the feed water. Assume that the circulating engine uses only 7½ lb. of steam, then 40 × 7.5 = 300 × 970.4 = 291,120 ÷ 45,300 = 6.4 deg. rise in the feed-water temperature. This difference must be made up from some other source, so that there is no real economy in using a highly efficient circulating-pump engine in this case. Every case should be calculated separately on its own merit.

To show the widespread interest in fuel and food conservation here, I may say that two subjects for prize competitions were published recently by some of the foremost men of our technical and commercial world, in which competitors are asked to propose methods for economy of heat force and food supply. The papers have not yet been published.

*Rijks-Landbouwingenieur, Wageningen, Holland.

Reverse-Current Relays

A new form of reverse-current relay, Figs. 1 and 2, has been developed by the Automatic Reclosing Circuit-Breaker Co. These relays are of the circuit-opening type and are so designed that the relay will open either upon reversal of current or with zero current at abnormally low voltage. The relay is closed and held closed by a shunt-polarizing coil *P*. A high resistance is connected in series with this coil. To close the relay a push-button switch is provided which temporarily short-circuits the high resistance. The high resistance limits the current in the shunt winding to just sufficient value to hold

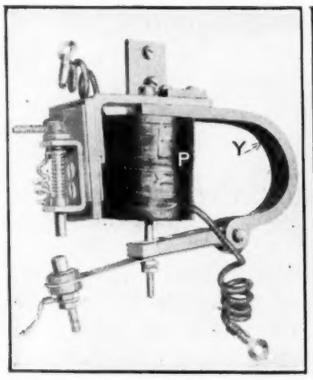


FIG. 1. RELAY, 1200 to 2000-AMP. SIZE

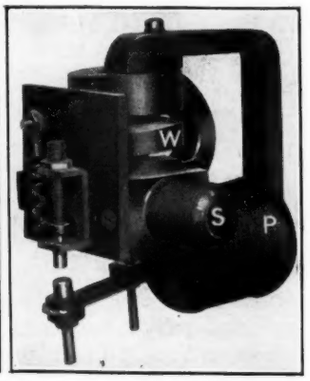


FIG. 2. RELAY, 400 to 800-AMP. SIZE

the relay closed. A reversal of current or failure of voltage will thus cause the relay to open. These relays are designed for mounting on the rear of the circuit-breaker panel. The 1200- and 2000-amp. size, Fig. 1, has a magnetic yoke *Y*, which surrounds the upper stud of the breaker, while the 400- and 800-amp. size, Fig. 2, is provided with a series winding *W*, one terminal of which connects directly to the upper stud of the circuit-breaker. The other terminal of this winding connects to a stud *S*, through which connection to the external circuit is made.

Editorials

This Time It Is Give, Not Lend

WITHIN less than a year the American people have responded to the call of their country three different times and have oversubscribed three of the largest loans ever floated in the history of the world, each time with an increased response as evidenced by the increase in the number of subscribers from about four million to the first loan to upward of twenty million in the third. The sale of War Savings Certificates is also meeting with a hearty response and by the end of the year will show that the American people are willing to back their Government to the last dollar. But all this money is only being loaned to the Government at a good rate of interest and will be paid back in full to each holder of these securities when they mature, and our enemies might have accused us of doing this simply because it was good financial policy had it not been for what the great American Red Cross has been doing on every battle front in the world, as briefly outlined on page 700 of last week's issue of *Power*.

In fact, when we entered the war part of the German propaganda in France was to create the impression that we were a nation of money grabbers, that we never did anything except for the money we could get out of it, that the vast sums we were investing in France for great military bases, railways and disembarkation ports were not for the interest of France but to use against that country after the war to further our own selfish interests. This propaganda might have succeeded, but the call was sent forth to the people of this country less than a year ago by the American Red Cross, not for a loan at a good rate of interest, but to give outright $100,000,000 to create a War Fund with which to finance the tremendous work of relief and reconstruction that was so vital to our Allies and ourselves in Europe, and that call was answered in a way that sent a message back to Europe that the American people had donated over $100,000,000 to the Red Cross War Fund, thus giving the lie to our enemies, the enemies of right and liberty, that we are a lot of wealth worshipers.

Before this war it was looked upon as the duty of the Red Cross to take care of the wounded, but conditions have changed and now it has become their work to provide everything that human beings need in a war-devastated country. This was very clearly shown in the previously mentioned report and is further emphasized by the following paragraphs taken from a Red Cross leaflet, "What Does the Red Cross Do?" by William Allen White, a copy of which can be secured by applying to any Red Cross Chapter:

"Over in France where French soldiers are coming back from the trenches on furlough, canteens have been erected by the Red Cross in order that the men might have lodging, food and bath, and a clean resting place. Such men return home clean and happy instead of wet and hungry. They come back from their homes to the trenches to fight, not in a sullen but in a happier frame of mind because of this Red Cross work. In France, too, the Red Cross supplies fuel and food and shelter to the soldier's families so that the men are prepared to stick—stick—and stick to the end, full of courage and ginger.

"Less than a week after the Italian breakdown the American Red Cross was in Italy with long lines of freight cars loaded with surgical supplies, food and clothing for civilians and distributing this aid to the hospitals and to the hundreds of thousands of refugees, men women and children, fleeing from the German invaders and making America felt for brotherhood in Northern Italy as no other country was ever able to make itself felt in the world before."

Since the first call the demands upon the Red Cross War Fund have been tremendous, the work accomplished staggers the imagination, but the first fund is nearing exhaustion, therefore the American people have again been asked to give $100,000,000 more, during the week May 20-27, to create a second War Fund so that the magnificent work that has been started may be continued. Let the answer to this appeal go echoing back to Europe from one hundred million loyal Americans that they have again cheerfully given over $100,000,000, to create a Second War Fund.

Give to your Red Cross until your heart says stop; it is "A great net of mercy drawn through an ocean of unspeakable pain."

Tube Failure in Water-Tube Boilers

TIME and experience have pretty well demonstrated that liability to complete disruption, with the destruction of property and loss of life that attends an old-fashioned boiler explosion, is much reduced in the water-tube boiler. The casualty statistics, however, show this type to be quite liable to local injury by rupture of the tubes, the bursting of a water tube being a much more frequent mishap than the collapse or failure otherwise of a fire tube. While most cases of bursting of water tubes undoubtedly result from overheating on account of oil or sediment preventing proper water contact, still there have been many such accidents that were apparently due to a breakdown of the strength and durability of the material under the stresses of long service. The latter cause may be wrongly ascribed for a tube failure on the strength of an absence of foreign matter from the surface of the tube, as revealed by an inspection following the explosion. The fact that no incrustation is found inside an exploded water tube is no indication that the rupture was not due to overheating. The shock at the instant of the explosion is pretty certain to jar the deposits loose, allowing the current of water and steam rushing at high velocity toward the opening to thoroughly wash them out.

When a tube failure results from overheating, the rupture is preceded by a softening and bulging of the

overheated area and a consequent distention of the metal, so that when it finally rips open, the edges of the fissure are drawn down to a knife-edge. Of course a thin edge along the rip might also indicate a wasting away of the material by corrosion and abrasion; but if such be the case there will be corroborative signs that will be absent if the injury has resulted simply from overheating. One of these signs is that if the tube is measured roundabout from edge to edge of the rupture, the distance will be found to equal the normal circumference of the tube. If the failure has resulted from overheating, the preliminary stretching to which the metal was subjected will be shown by the measurement roundabout at the place of rupture being greater than the normal circumference.

A particularly insidious cause of injury to water tubes is the oil that gets into the boilers in plants where proper means are not used to separate the oil from the exhaust steam that goes to heat the feed water. A very small quantity of oil thus misplaced can do an immense amount of damage. It may also prove very elusive. It may spread out on the metal surface in a film so tenuous, or may combine so unobtrusively with the solid impurities to form sludgy deposits, as to escape even the practical eye and touch of the inspector. Overheating on account of oil usually extends over a larger area, and the resulting rupture is more violent in its effects than where the destructive agent comprises simply the ordinary scale-making ingredients, and these indications furnish the only guide in assigning the true cause of failure in many cases.

Scrupulous care should be exercised to keep oil out of steam boilers. Very often those responsible appear to be lacking in appreciation of the injury it can do, if one is to judge by the indifference manifested toward the oily scum that is to be seen on top of the water in many gage-glasses. When a grease line shows in the water glass, it is high time to do some industrious figuring on the problem of purifying the exhaust steam before it mingles with the feed water. Oil-extracting apparatus is to be had, which, if intelligently installed and cared for, will eliminate danger from this source.

But the tubes of a water-tube boiler may be free from scale and oily deposits, and still burning and bagging will develop by reason of the extremely hot fires commonly carried in large power stations. The bottom rows of tubes invariably suffer in such service, notwithstanding extreme vigilance to keep them clean. It is possible that the water coursing through these tubes is heated so rapidly that it cannot pass out quickly enough to carry away the globules of steam as fast as generated, with the result that they gather momentarily in pockets next the surface of the tube, thus excluding the water from contact with the metal. It is presumed, of course, that the accumulation of steam bubbles is of very short duration; but with the fierce heat of the furnace impinging directly upon the tubes with the concentrated intensity of a blow-torch, it requires but little time to soften the thin area of exposed metal to the bulging point, and a bag is the immediate result. Often a tube is found bagged along the sides. This seems to substantiate the theory of burning on account of steam pockets, since the natural precipitation of foreign particles in the water would evidently result in bags due to this source appearing along the bottom of the tube.

A variety of causes may contribute to the deterioration of water tubes. Of these the corrosive action of acids in the feed water internally and of sulphurous compounds externally are perhaps the most common. The fine fly ash that collects around the ends of the tubes and works in beneath the baffle tiles is also a prevalent source of decay. Removal of these deposits is an item that is generally neglected when the boiler is gone over at cleaning time. Great care will be observed to keep the insides of the tubes clear of corrosive agents, but little attention will be given to the outside. With some makers of water-tube boilers the water that is splashed around while washing out works in between the headers and through hollow stay-bolts, thus saturating the deposits of fine ash and initiating a rapid process of corrosion, perhaps utterly spoiling some of the tubes if the boiler stands idle for a considerable space of time. Instances have also been reported of baffled tubes having been worn dangerously thin by rubbing on the tiles due to the constant changing of form in the boiler.

Sometimes a water tube lets go on account of an imperfect weld. In such cases there can be no room for conjecture, the evidence of deficiency in a broken weld being so plain that the cause of the failure is never in doubt. There can be no absolute certainty about the security of a weld. Despite the utmost precaution in the manufacture of lap-welded tubes and rigid inspection of the product as it comes from the mill, defects in the welding will now and then crop out. Instances of imperfectly welded tubes continuing in service for months before bursting open have been reported.

The fluctuation of pressure and temperature in the ordinary working of a boiler, by producing a succession of molecular stresses that tend to crystallize the material, is also an active cause of deterioration, although its effects are never manifest to ordinary inspection. Loss of tenacity and ductility, and of the essential property of resilience or springiness is the inevitable penalty of age in a steam boiler. In water-tube boilers the tubes have practically the whole burden of service, since they comprise almost the entire heating surface of the structure; they fulfill, in fact, so far as absorption of heat is concerned, the same purpose as the more substantial furnace sheets of fire-tube boilers. The tubes should therefore be the objects of critical inspection. As the boiler ages, even though the tubes be kept free from oil and scale and show no visible signs of decay, it might still be the part of prudence to cut one out once in a while so as to determine by test just what the condition of the material may be.

The most unfortunate thing about a water-tube explosion is that it generally means death or painful injury by scalding to the fireman or stoker attendant, and perhaps to others who may be near-by; the damage to the boiler and setting in most cases is small and easily repaired. The menace to human life that is involved is certainly the outstanding reason why every precautionary measure available should be applied to minimize these accidents.

The most hopeful item of news bearing on the possibility of a coal shortage next winter is the announcement of an order by the Government, with deliveries promised through the summer, of 1025 locomotives and 100,000 freight cars.

Correspondence

A Talk to Firemen on Saving Coal

I read with interest the lecture by Mr. Bromley at the Baltimore City Club, as published in *Power* some time ago (Jan. 22 issue). The American Society of Mechanical Engineers deserves praise for bringing about such a meeting. More should be done in that direction.

"Employers Need Education" reads a subhead in the article. This is true, indeed. As every engineer knows, when he asks his employer for a new device, one that invariably is sure to save coal, he is usually told to wait, that labor and material are too high at present. The engineer usually concludes then something like this: "Very well, Mr. Employer, if you do not want to listen to me, you can go on wasting coal. I do not have to pay for it directly." But this attitude is as disagreeable to the engineer as to anyone else.

Here are some suggestions on coal saving that engineers may find applicable without the use of new apparatus.

When a plant of any size is started in the morning, generally engines, pumps, etc., are started some time before the working day begins; that is, before the load comes on. The engineer should have the machines warm, but start them as near the beginning of the working day as conditions permit. Do not have machinery running before it is needed. At noon be ready to shut down as soon as the whistle blows. In the evening perhaps some of the engines or other machines may be shut down before quitting time. Do not wait until you shut down all the other machines just to save a trip. Send the oiler or helper to do it if you are too busy. The heads of the different departments should coöperate with the engineer and notify him immediately when they can spare an engine; also they should not allow their men to waste steam.

The engineer should keep in close and constant touch with his fireman, should let him know when the heavy load is about to come on or be taken off. If the fireman is treated that way, he will no doubt like his engineer and take more interest in the work. During the time the plant is in full operation, the fireman should not be called to do work other than caring for the fires and the boilers.

WILLIAM L. KEIL.

Philadelphia, Penn.

Setting the Clock Back Again

The editorial in the issue of Apr. 9 on daylight saving seems timely, and I hope the solution will put all sections of the country on a more equal basis with reference to the sun. The Central and Mountain Standard zones are too wide at present to give all parts of the zones an equal chance to get the most benefit from the available daylight. To illustrate, consider two strips of territory—the eastern and the western fourths of the Central zone. The recent change of the clock puts the western strip one and one-half hours ahead of the sun, which is excessive, as it will necessitate the use of light in the mornings till well toward summer and for a period in summer it will be bedtime by the clock while yet daylight, both of which factors tend to defeat the purpose of the law; while the eastern strip is merely advanced to the position formerly held by the western, and as far as daylight saving is concerned, the eastern strip is doing no different under war conditions than has normally been done in the western strip ever since standard time was adopted.

Another feature is this: Under the old way the daylight comes so close to 6 p.m. in the western strip that the peak before 6 p.m. is negligible, while in the eastern strip, which is one of the greatest coal-consuming sections of the country, they have had the extra burden of an enormous peak load for some time before 6 p.m. every day. I have often wondered why more of the cities in that section have not adopted local time to do away with the burden, but the reason probably is that habit has such a hold on men.

As to keeping the clock as at present the year round, it would put the eastern strips of the Central and Mountain zones in the positions formerly held by the western strips, or local time would be about half an hour ahead of the sun, which I consider almost the ideal. Perhaps 45 minutes ahead of the sun would be a little better as it puts the sun on the meridian almost exactly midway of the working day. It would do away with the greater part of the peak load before 6 p.m. in winter and in summer would give all the extra daylight needed. It would produce an increase of load in the morning, but not nearly as much as to offset the gain caused by the drop of the early evening load. If it is decreed that the clock shall not be put back, I hope that the Central and Mountain zones will be split into several, for unless that is done the inhabitants of this strip will be groping in the dark "of mornings" for three-fourths of the year.

Exeter, Neb. W. M. ALEXANDER.

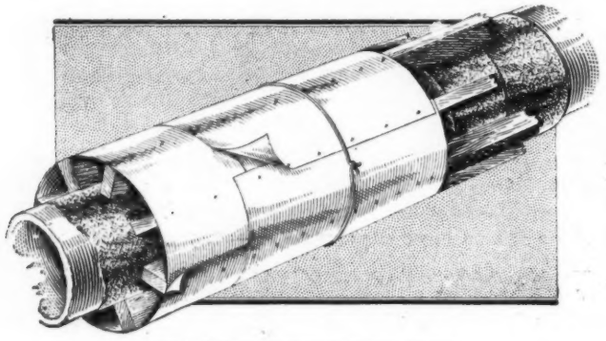
Burning Slack Containing Excessive Moisture

In my article in the issue of Apr. 2 on "Burning Slack Containing Excessive Moisture," an error in the printed figures has been brought to my notice, the stoker speed in our test being stated as averaging 2 ft. per min. This is obviously a mistake, and I find my original copy reads "No. 2 Stoker Speed," which is the record of the indicator connected to the stoker grate. In case this should not be clear, I recently checked the actual speed of this grate at the speed given, and find it moves 1 ft. in 5 min. The grate frontage is 7 ft., and the thickness of the fire 4 inches.

Calgary, Alta., Canada. JAMES F. MCCALL.

Easily Made Pipe Covering

The illustration shows how a fairly good pipe covering can be easily made. To lengths of building or tarred paper three or four feet long (the usual width of the roll) nail strips of wood equally spaced and about three inches short of the edges of the paper, as shown. This completes the outside of the covering. Wrap



COVERING APPLIED TO PIPE

asbestos paper around the pipe to be covered and tie it on with stout twine, then put on the strips of wood and tarred paper and tie them on with a few turns of wire. This makes a fairly good insulator at a low cost. Care should be taken to see that the outside paper joints overlap at the sides and ends and that there are no holes, as the efficiency of the insulation depends to a large extent on the dead-air space. Painting the covering over occasionally with hot pitch will improve its quality and life.

JAMES E. NOBLE.

Portsmouth, Ont., Canada.

How Pat Saved a Barge by Sinking It

His name was Pat and his hair was as red as his wit was spontaneous. He was a shoveler on a coal barge on one of the steel company's routes up the Allegheny. The particular coal barge on which Pat was stationed was "docked" for the winter above the Sharpsburg bridge, and it was Pat's duty (and his pleasure be it said) to board the barge every morning and see if it was dry and, if not, to pump it out.

Pat was fulfilling his responsible duties one day while a carpenter was busy at work repairing the footboards of the barge, and all the while the water was rising in the river at the rate of about a foot every two hours. About noontime Pat said to the carpenter: "It is meself that's thinkin' that the wather is low enough to rise higher and if the ice comes down from up beyant, this old boat will be our coffin, begum."

The carpenter, looking upstream, saw a white streak coming around the point at Aspinwall and shouted to Pat to pull the barge to shore, knowing from experience that this white streak meant ice and that ice with a current meant—well, not death, but as near to it as he wanted to be. Pat tugged on the lines forward and the carpenter pulled on the lines astern, but with the current in the river about six miles per hour, the ice came down on the barge, tearing it from its moorings with Pat and the carpenter still on duty at their respective posts.

As Pat was forward at first and the carpenter astern downstream, Pat thought it his duty to be subordinate to his superior; but as the ice took the barge with Pat at the stern, as it were, he became captain and forthwith commanded the other to keep a sharp lookout for a jumping-off place. When they neared the P. R.R. bridge, the lookout yelled: "Pat, we are done; the water is so high that we can't go under the bridge, and the two of us and the barge will go to hell in ten minutes."

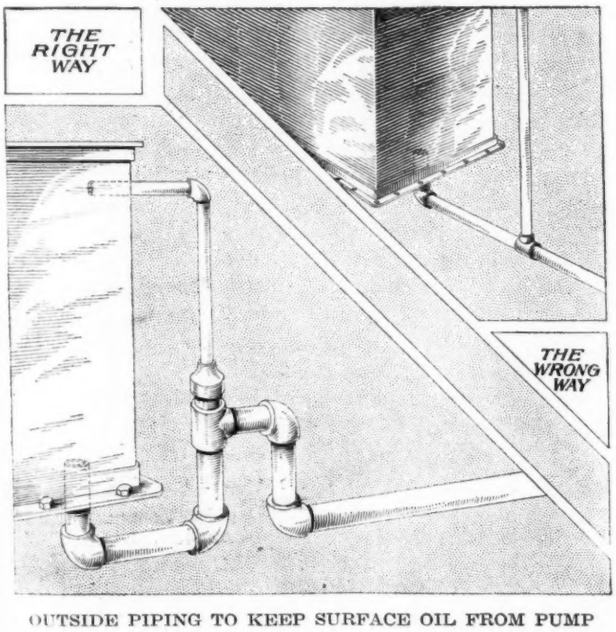
Pat, the captain, yelled: "Take your domn auger and bore some holes in her bottom to let the water in and get her low enough to go under the bridge; then plug the holes." It was done, with the result that Captain Pat and the carpenter were taken off the barge at East Liverpool and the barge was salvaged at Newport, Kentucky.

G. E. MICHAEL.

Pittsburgh, Penn.

Keeping Oil Out of Feed Pump

The same principle involved in the piping arrangement shown by T. A. Marshall in the issue of Apr. 30, page 630, that makes it impossible to entirely empty a receiving tank or heater by accident and get the oil and scum that is always found floating on the top of the water into the feed pump and boilers, may also be applied, as shown in the illustration, to open heaters, etc., in which there are trays and the like in the way of internal piping. The pump suction from the heater should be arranged somewhat as shown to form a seal, and a small vapor pipe connected from the tee at the top of the seal



OUTSIDE PIPING TO KEEP SURFACE OIL FROM PUMP

to the steam space of the heater or tank. The action is, of course, the same as that described by Mr. Marshall. It is not safe to allow the vapor pipe to be simply open to the atmosphere in case of a closed tank, because, in the event of even a slight pressure in the heater, all the water may be discharged from it before the pump gets air or vapor. Connecting a vapor pipe into the side of a tee, as I have seen tried, won't do either, for obvious reasons.

New York City. J. LEWIS.

Fitting a New Piston Valve

My experience in putting a new piston valve in a Buckeye engine may be of value to some brother engineer, so I give it for what it is worth.

After pulling in the new valve-chest bushing, which necessitated the removal of the crank-end valve-chest head and stuffing-box, my assistant replaced the head, and upon attempting to insert the new valve I found it rather a snug fit; in fact, it would go only about halfway in. I discovered that the valve rod was binding on the top where it passed through the stuffing-box. The shoulder on the chest head, intended to fit the counterbore of the chest, was about one-eighth inch smaller than the bore, which allowed the head to drop down out of line; the slack of the studs in the holes also allow this. Loosening the stud nuts and raising the chest head slightly so the stuffing-box would be central with the valve-chest bore corrected the difficulty, and the valve entered properly. W. D. WAKEMAN.

Deposit, N. Y.

Single-Phase Motor Would Not Carry Its Load

Some time ago I had occasion to investigate trouble in a single-phase motor of the split-phase, clutch type that would not carry its load. It would start and increase in speed until the clutch began to grip, and at this speed it would remain until all the load was taken off, when it would come up to full speed. If the load was put on again, it would slow down until the clutch slipped. Considerable work was done on the clutch as the electrician thought the trouble was in this part of the equipment. However, when I investigated the matter, I found many of the rotor bars loose, and upon resoldering these, the motor ran as satisfactorily as when new. The reason for the motor slowing down is as follows:

The action in a single-phase motor is somewhat different from that of a polyphase machine. In the latter the revolving magnetic field is independent of the rotor's speed. A resistance in the rotor circuit will have the effect of changing the speed at which the maximum torque will take place, the maximum torque being of practically the same value regardless of whether it occurs at standstill or near full speed.

In the case of the single-phase motor the revolving field is dependent on the rotor's speed, being maximum at full speed and becoming simply a pulsating field as the rotor comes to rest. In this type a rotor resistance not only has the effect of reducing the speed at which the maximum torque will be developed, as in a polyphase machine, but also it reduces the amount of torque until at standstill the torque becomes zero.

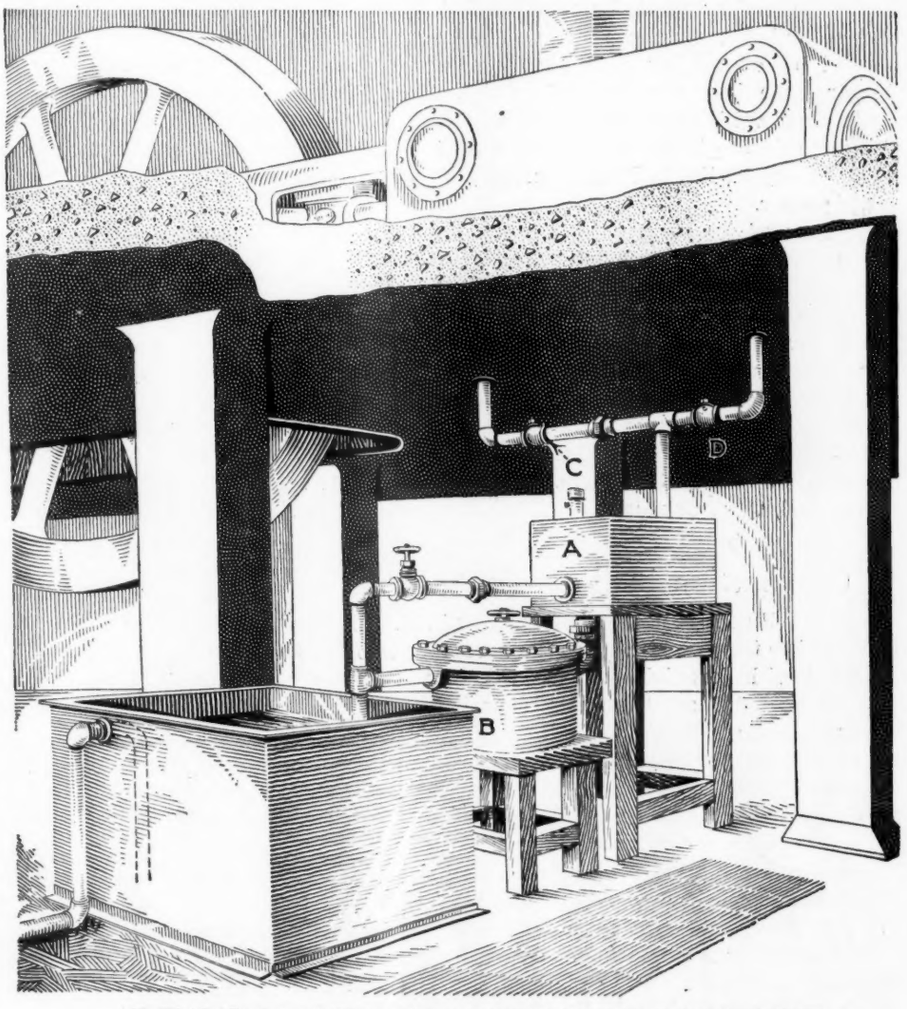
Adams, Mass. ALBERT CARPENTER.

Cylinder-Draining System

The illustration shows a rather elaborate cylinder-draining outfit that may be interesting. The globe valves on the drain lines above the floor are not shown; *C* and *D* are check valves, *A* is a cast-iron receiver and *B* is a trap.

Considerable water came over with the steam at times, but by leaving the draining valves above the floor open, the water got away all right. It was found that the cylinder oil soon closed up the trap discharge, so the outlet was drilled out to about twice its former diameter, and it did not choke up any more. The trap discharged into an open tank with a discharge overflow as shown, and most of the oil was skimmed from the top of the water in the tank and after being passed through a filter was used for oiling shafting, etc.

Portsmouth, Ont., Canada. JAMES E. NOBLE.



AN ELABORATE SYSTEM FOR DRAINING WATER FROM CYLINDER

Burning Slack Containing Excessive Moisture

The stoker setting described in J. F. McCall's article in the issue of Apr. 2, page 472, is by no means new, being generally similar to a standard Babcock & Wilcox Limited chain-grate stoker setting for low-volatile coals, which has been used for many years in England and Europe. In 1913 one of these B. & W. stokers was installed at the University of Alberta, Edmonton, which has proved very satisfactory in burning the Edmonton lignites, and a series of tests were being carried out by C. Robb, professor of mechanical engineering, when the war broke out and the work was held up. Some changes in the settings of the chain-grate stokers along the same lines have been made at the city power plants of Edmonton and Saskatoon by their city engineers.

While Mr. McCall's setting includes the essential center arch with an opening behind it, which is the best arrangement possible without more extensive changes to the standard bituminous-coal setting, still better results would probably be obtained by the regular B. & W. setting in which the back arch is set at a slope to obtain the maximum reflecting power, the grate inclined and a larger combustion space obtained by increasing the furnace height. The horizontal front arch is of little value, and as sub-bituminous and lignite coals do not take long to burn out, the length of the grate need not as a rule be over ten feet, the front of the stoker being set closer into the front of the boiler. This type of setting will prove satisfactory when burning the better grades of lignite. For lignites containing a high percentage of moisture, a special extension is employed at the front of the grate for partially drying the fuel before passing on to the chain grate proper.

In view of its present importance the question of the most satisfactory way to burn the Canadian lignites is engaging the general attention of engineers, and the Canadian government recently passed a special grant for an experimental plant in Saskatchewan. While some valuable investigations have been carried out by the United States Bureau of Mines, it would be of additional interest to hear from others who have had experience in burning lignite containing over 25 per cent. moisture under boilers. F. A. COMBE.

Montreal, Que., Canada.

Combustion in Boiler Breechings

I read with interest the experiences of Mr. Sonntag in regard to the gas burning in the breeching of boilers equipped with forced-draft apparatus, in the issue of Mar. 26, page 448, and having had experience with high-volatile coals and various kinds of furnaces, I think possibly the following may be of interest. I feel sure that Mr. Sonntag's conclusions are correct—that the gas burning in the breeching is the result of insufficient oxygen to support combustion, which causes the flame to reach out for more. A kerosene lamp will demonstrate this condition, as any slight reduction of air through the burner will cause the flame to lengthen.

It is generally recognized that successful forced-draft installation depends on a restricted and uniform air supply to the fire. Eliminating excess air is vital to good efficiency, so that the foregoing condition warrants a lot of consideration, as there is a possibility that the condition that did exist in this case could be made to produce remarkably good results if a few minor changes and experiments had been made. For such a condition I would suggest a few encircling tile directly over the bridge-walls to give the gas an incandescent surface to impinge on, creating a zone of much higher temperature than can be obtained otherwise, and then by firing alternate doors there is a chance for the fire to get sufficient free oxygen well mixed and ignited at this point, so that the gases will be consumed in the combustion chamber instead of in the breeching. A still better method is to construct arches of short spans, approximately four feet wide, over the bridge-walls, which, on account of being narrower than the boiler, will make a much better mixing medium.

I have records of tests on Heine boilers with properly arranged forced-draft grates and furnaces, using Southern Kansas coal of a very rich volatile content, where the temperature in the combustion chamber reached over 2000 deg. F. when carrying heavy loads, and the stack temperatures reached but a fraction over 600 deg., with the waste gases showing only a trace of carbon monoxide. I have also made exhaustive experiments at a reduction works in Colorado City, where Colorado lignite coal is burned with a forced-draft furnace especially designed for that fuel, in which preheated air is introduced between the furnace and the combustion chamber; and by controlling this air, the length of the flame on the hearth can be changed from 20 ft. to as high as 70 ft. The flame can be controlled in the same way under the boilers, which are similarly equipped in this plant. Forced draft is getting to be the favorite method of burning slack and high-volatile coals on account of the high boiler efficiencies maintained. My experience has taught me that it is much easier to add a little air at the proper place in a furnace under slight pressure than to fight the eternal excess that filters through boiler settings and fuel beds in poor condition caused by poorly designed grates. WILLIAM J. MANHIRE.

Kansas City, Mo.

Volumetric Efficiency of Air Compressors

The apparent volumetric efficiency of an air compressor is the apparent volume of free air drawn in divided by the piston displacement; the cylinder clearance is, of course, considered in the calculation or determination. This efficiency is usually about 96 to 97 per cent. with modern valves.

Paradoxical as it may seem there is a two-stage steam-driven air compressor at Newport, R. I., that shows a volumetric efficiency of 116.8 per cent. as shown in the records of tests on file in Washington. You don't believe it? Neither did I when it was first brought to my notice, but I believe it now. Here is the reason: The cold-air inlet is a long pipe extending to the river bank, and when suction starts in the compressor it sets in motion the long column of air in the inlet pipe, the momentum of which partly compresses the air in the low-pressure cylinder before the inlet valves are completely closed. Do you believe it now?

Pittsburgh, Penn. G. E. MICHAEL.

Inquiries of General Interest

Effect of Superheating on Valve Leakage—What effect has the use of superheated steam on the leakage of engine valves? W. R.

In all forms of valves the tendency to leakage is increased, as the higher temperature of the steam causes greater distortion of the parts and at the same time the steam is less dense.

Quick Rise of Compression Line of Indicator Diagram—What causes the quick rise in the compression line frequently observed in steam-engine indicator diagrams? W. R. S.

A quick rise of the compression line may be due to the compression steam taking up heat from the cylinder and also may be due to the addition of steam that has leaked past the inlet valve.

Expansion Tank for Hot-Water Heating—What size of expansion tank would be suitable for a hot-water heating system having about 750 sq.ft. of radiation? S. F.

Expansion tanks for hot-water systems containing 500 to 1000 sq.ft. of radiation should have a capacity of about 1 gal. per 40 ft. of radiation. For 750 ft. of radiation a tank of 20 to 25 gal. capacity would be sufficient.

Ratio of Expansion—What is meant by ratio of expansion in a simple engine and in a compound engine? J. L.

The ratio of expansion of the steam used in a simple engine is the quotient derived by dividing the final volume of steam found in the cylinder by the initial volume. By initial volume is meant the volume of steam admitted to the cylinder up to the point of cutoff plus the clearance volume, and by final volume is meant the volume of the cylinder, plus the clearance volume. In a compound, triple or any other form of stage-expansion engine, just as in a simple engine, the total ratio of expansion is the ratio of the final volume of steam found in the last cylinder to the initial volume in the first cylinder.

Dry Pipe Preferable to Steam Dome—Why is a dry pipe for a horizontal return-tubular boiler preferable to a steam dome? S. P.

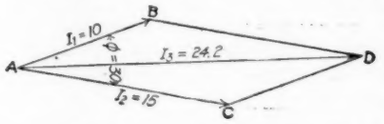
A steam dome takes up headroom, affords a large surface for loss of heat and the construction impairs the safety of the shell. The strength of the riveting and staying of a dome to the shell is uncertain, as it depends on the holding power of rivet heads, and the unequal expansion of the dome flanging and boiler shell is likely to cause leakage that cannot be stopped by calking. None of these disadvantages is present from use of a dry pipe, and when it is properly designed and placed within a boiler, mechanical separation of water that is entrained in the steam may be obtained as effectually as by use of a dome of ordinary dimensions.

Changing Direct-Current Motor's Voltage—What changes are necessary to be made in the windings of a 4-pole 240 volt compound-wound motor, running 1350 r.p.m., to operate on 115 volts and run at one-half its original speed, or 675 r.p.m.? T. A. M.

The only changes necessary are in the shunt-field windings. The shunt-field coils must be arranged in two groups of two coils in series in each and the two groups connected in parallel. To obtain the same amount of compounding as when the machine was operating on 240 volts it will not be necessary to make any change in the series-field windings. The machine will take the same current at full load on 115 volts as it did on 240 volts and develops one-half the number of horsepower. On account of 115 volts being slightly less than one-half of 240, or 120 volts, the speed on the new connection will be slightly less than one-half that on the higher voltage. The ventilation will not be quite so good on the lower speed, therefore the full-load temperature may be somewhat higher at the low speed.

Value of Two Alternating Currents—An alternating current of 10 amperes is out of phase by 30 deg. with a second current of 15 amperes. What is the resultant value of the two currents? H. F. S.

The resultant of two or more alternating currents in a circuit is always equal to their vectorial sum. The angle between the two currents in this case is 30 deg., hence the



angle ϕ, between AB and AC representing the two currents in the figure, is made 30 deg., and by completing the parallelogram the resultant AD is obtained, which represents to scale what an ammeter would read when the two currents were flowing through it. This resultant may be calculated by the formula,

$$I_3 = \sqrt{I_1^2 + I_2^2 + 2I_1 I_2 \cos \phi}$$

$$= \sqrt{10^2 + 15^2 + (2 \times 10 \times 15 \times 0.866)} = 24.2 \text{ amperes}$$

Determining Advantage of Speeding Up Engine—How is it determined whether there would be an advantage from speeding up a Corliss engine with the present load? W. V. B.

As the advantage would depend on the superior economy from shorter cutoff combined with increased piston speed, the first step would be to determine the mean effective pressure necessary and from that to determine the new point of cutoff and the relative steam economy at the proposed speed. For the same load, the m.e.p. to be realized with different speeds is inversely as the speeds, and the required m.e.p. would be found by multiplying the present m.e.p. by the present speed and dividing the product by the proposed speed. Adding the m.e.p. to the average absolute back pressure gives the average absolute forward pressure and this divided by the absolute initial pressure will be the average forward pressure to be realized per pound of the initial.

Inspection of a table of mean pressure per pound of initial with different clearances and points of cutoff (such as given on page 115 of Low's "Steam Engine Indicator") will show the point of cutoff required. The relative amount of steam admitted with the present point of cutoff and number of strokes per minute can be compared with that required by the new point of cutoff and proposed number of strokes per minute. Such a comparison can only be approximate, however, as in the different cases there is likely to be different variation of the actual from the theoretical diagrams made by the engine. A closer estimate of relative economy could be made from comparison of actual diagrams obtained with the present speed for the average load and with the engine loaded only sufficiently for obtaining the m.e.p. that will be required by the proposed speed. If the proposed increase of speed is within limits of safety and certainty of operation of the engine, feed-water tests of economy of steam required per horsepower per hour for the present average m.e.p. and for a load that requires approximately the proposed m.e.p. at the present speed would give results near enough for all practical purposes to be regarded as identical with relative results of tests made at the actual speeds.

[Correspondents sending in inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Washington & Idaho Water Power Co. Valuation

In the hearings being conducted by the public-service commissions of Washington and Idaho at Spokane relative to the value of the Washington & Idaho Water Power Co., R. H. Thomson, former city engineer of Seattle, gave the properties a substantial boost in value.

Called as an expert on power-site values, he has given two months since the adjournment of the hearing in February to a study of the company's power sites, water-storage system, power plants and their relative costs as compared with other plants similarly situated. The total value of the company's properties is given as $26,000,000.

Engineer Thomson found that the power development of the Washington Water Power Co. was installed at a much less cost than that usually estimated, and for that reason he placed a valuation on the company's power plants, overflow rights and impounding systems of approximately $5,000,000 more than its book costs show. He called this the "value of opportunity," which he held entitled the company to a valuation which it would expect to ask were it about to sell its property to an outside purchaser. Should the joint commission accept the views of Thomson, it will mean an addition of 20 per cent. to the value of the company's property as given in former testimony and will entitle the company to increase its rates.

The Washington Water Power valuation hearing is being held preliminary to rate making by the public-service commissions of Washington and Idaho. The appraisal by the engineers of the Washington and Idaho commissions has been in progress more than three years. The greater part of the testimony of the engineers for the two states was taken in February, at which time R. H. Thomson was retained for a further inquiry as to power-site values by the Washington commission, and the City of Spokane retained Otto A. Weille, former city engineer, for testimony in behalf of the city. J. C. Ralston, former city engineer, appeared as an additional expert for the Washington Water Power Co., making three engineers representing the company, the others being Carl F. Uhden, chief engineer for the company, and Henry L. Gray. J. B. Ingersoll, former chief electrical engineer for the Inland Empire system, attended the hearings in consultation with counsel for the city.

For the Washington commission are appearing E. F. Blaine, chairman; F. I. Spinning, and Harry Lewis. The members of the Idaho commission in attendance are John W. Graham, chairman; George E. Erb and L. A. Freehafer. Hans Cleland, assistant attorney general, appears as counsel for the state, and J. P. Pope, assistant attorney general of Idaho, is counsel for the commission of that state. Frank T. Post is counsel for the Washington Water Power Co., and Mayor C. M. Fassett, J. M. Geraghty, corporation counsel, and A. M. Winston, assistant corporation counsel, appear for the city. D. F. McCurrach, acting chief engineer, and J. S. Simpson, former chief accountant, appear as technical experts for the Washington Commission. W. G. Swensden, chief engineer for the Idaho commission, is in attendance.

R. H. Thomson, the first witness called, said that power sites installed under similar conditions as those that obtained with the Washington Water Power Co. cost $225 per hp. The great Montana plants, the closest competitors of the Washington Water Power Co., he said, cost $215 per hp. He was surprised at the comparatively low cost of horsepower development shown in the invoice costs of the Washington Water Power Co., which is lower than the average costs over the country. He said that this difference is due to the advantageous location of the company's four plants on the Spokane River, with common impounding of water-storage facilities in Cœur d'Alene Lake. The company appears to have exercised prudence and close supervision in the building of its plants, as disclosed by its book costs. He claimed that the company in determining the value of its property is entitled to the difference in what its development has cost per horsepower as compared with what similar developments have cost elsewhere. Allowing ordinary conditions of growth and a favorable field in so far as competition is concerned, he would place this value of opportunity at $4,931,251.

Engineer Thomson produced the cost of power development per horsepower for the plants of the Washington Water Power Co., together with the credit due each plant compared with the going costs of such development for other companies:

Plant	Cost per Hp.	Hp. Development	Credit Due
Post Falls	$168	5,930	$278,710
*Spokane	151	26,700	1,708,000
Long Lake Plant	147	42,918	2,918,220
Little Falls Plant	120	18,130	1,722,350

* Estimated on basis of proposed new $3,000,000 plant.

He stated that this makes a total excess value of $6,628,080 over and above what might be styled invoice value of water rights and sites, including lands for impounding purposes, belonging to the Washington Water Power Co. This sum plus the invoice value will be at par at such time as the market demands of the territory will consume the normal output of the plant. Figuring on the basis of ten years being required for the territory to absorb the full output of the company, $4,931,251 would be a conservative figure as to the excess value.

Engineer McCurrach, for the Washington Commission, presented a supplemental report, bringing the appraisal of the Washington Water Power Co., to December, 1916, as compared to June 30, 1915, the date covered in his first report. This subsequent appraisal is based on additions actually made to the properties since June 30, 1915, as shown by the books of the company. Prices are based on the five-year average from 1910 to 1915. Following are the figures:

WASHINGTON PROPERTIES

	June 30, 1915	December, 1916
Railway system	$5,502,422.00	$5,593,214.00
Light and power system	13,505,694.00	13,834,977.00
Nonoperating property	893,855.00	893,785.00
Totals	$19,901,971.00	$20,321,976.00
Land railway	447,004.00	438,453.00
Land-light and power	1,114,904.00	1,114,232.00
Totals	$1,561,908.00	$1,552,685.00

IDAHO PROPERTIES

Light and power systems	$2,326,669.00	$2,478,890.00
Nonoperating property	42,586.00	42,586.00
Totals	$2,369,255.00	$2,521,476.00
Land-light and power	123,560.00	143,203.00
Grand totals Washington and Idaho	$23,956,694.00	$24,519,340.00

Another table of appraised values was presented by Engineer McCurrach, prepared at the request of F. P. Post, attorney for the power company, based on prices prevailing from 1912 to 1916, a period in which materials and labor cost more. These figures showed:

Washington totals	$23,490,484.00
Idaho totals	2,839,626.00
Grand total	$26,330,110.00
Increase over regular appraisal figures	1,810,770.00

The appraisal of Engineer McCurrach on the railway property of the company to December, 1916, on the 1910-15 basis shows:

Spokane Street Railway	$4,732,521.00
Interurban System	860,693.00
Lands—Spokane Railway	250,761.00
Lands—Interurban	178,692.00
Total	$6,022,667.00

A calculation of what he thought was a fair system of annual depreciation allowances to be made on the property of the Washington Water Power Co. was presented by Mr. McCurrach, showing:

	Per Cent.	Amount
Spokane Street Railway	3.99	$191,185.00
Interurban railway	3.85	32,613.00
Light and power, Washington	3.51	480,862.00
Light and power, Idaho	3.49	86,067.00
Total annual depreciation	3.71	$790,727.00

Remember, oil is lazy and very unobliging; it will never accommodate you by working to the center of a bearing, but will always work from the center out.—*Marine Engineering.*

Fuel Conservation by Off-Peak Rates for Isolated Plants

The testimony presented at the resumed hearing before the Public Service Commission for the First District of New York, on May 13, was of a character intended to establish the superiority of the isolated plant over the central station under certain conditions of operation and to bring out the idea that fuel can be saved to a community by permitting isolated plants to purchase current from public-service plants during the nonheating season and generate their own electricity during the heating season.

The plant of Saks & Co., Broadway and 34th St., furnishes light and heat to a seven-story building, as well as steam for operating elevator pumps. For about a year after the building was opened, in 1902, the plant was run to furnish light, heat and power. From December, 1903, to November, 1914, the plant discontinued the generation of electricity and purchased the necessary current for lighting from the Edison company. At the end of this period, however, electric generation in the plant was resumed.

A comparison of the costs of operation in 1913 and 1915 is interesting. In 1913 the purchased current cost $21,000 and the cost of operation of the plant to supply steam for heating and for running the elevator pumps was $17,000, making a total of $38,000. In 1915, with the plant supplying light, heat and power, the total cost of operation was $28,850, representing a saving of $9150 over the expense of operation in 1913.

During the heating season, the exhaust steam from the elevator pumps is sufficient to supply practically two-thirds of the heating, the remainder being made up by live steam. In the nonheating season, there is no way of utilizing the exhaust steam, and consequently it goes to waste. If a summer rate for current could be obtained, equal to or less than the cost of production in the plant, the plant could be shut down in the nonheating period with a resultant saving to the community of about 360 tons of coal. Approximately 180,000 kw.-hr. is needed during the nonheating season, and the generation of this current by the central station instead of the isolated plant could be done on at least 4 lb. of coal less per kilowatt-hour, amounting to a saving of 720,000 lb., or 360 tons. During the heating season, however, the central station would have no such advantage over the isolated plant, as the latter would use its exhaust for heating.

The plant of Bonwit Teller & Co., Fifth Avenue and 38th St., supplies steam for the operation of engines driving electric generators, for running refrigerating machinery and for heating. Comparison of the cost of generating current in this plant, as taken from the plant records, and buying it from the Edison company shows that the former is about half as large as the latter. The reason is that no exhaust steam is wasted, in the heating season, as it can all be used in supplying heat to the seven-story building in which the plant is situated.

The shutting down of the electric-generating part of the plant would have little value as a coal-saving scheme. About 14 tons a day is required for heating, and if current for lighting is generated, the coal consumption is only about 17 tons a day. The number of kilowatt-hours generated, however, is much greater than the central station could produce with the 3 tons of coal representing the increase of coal consumption, because the isolated plant obtains the current as a byproduct of the heating system.

The Columbia Trust Co., 60 Broadway, installed a private electric plant in 1915. Before that time current had been purchased from the Edison company, and an isolated steam plant had furnished the heating and run the elevators. The result is that the electric plant has saved enough to pay for the cost of installation and all interest charges. The saving for the year ending Oct. 15, 1916, was $10,171 and for the year ending Oct. 15, 1917, was $11,396. These savings were calculated on the basis of the Edison rate for current before the electric plant was installed. For example, in the year ending Oct. 15, 1916, the electric current used would have cost $19,494 at the Edison rate. The heating would have cost $7938 more, making a total expense of $27,432. The actual operating expense for that year was $17,261, so the amount saved was $10,171.

Percival R. Moses, who has had a wide experience in designing private plants for buildings, appeared in behalf of the isolated plant. He advocated coöperation of the public-service utility and the isolated plant as the solution of the coal-conservation problem. His plan would be to shut down the private plants during the nonheating season, when they have no use for exhaust steam and could therefore operate only wastefully, and to establish a low rate whereby they could purchase current for lighting during this period from the public-service plants.

The views expressed by Mr. Moses are given at considerable length in an article by him in the Mar. 26, 1918, issue of *Power*. He said in his testimony that the Chicago Edison Co. has established rates for off-peak service to isolated plants during the nonheating season, as follows: 3c. per kw.-hr. for the first 25,000 kw.-hr.; 1.3c. per kw.-hr. for the next 25,000 kw.-hr.; 1.1c. per kw.-hr. for the next 70,000 kw.-hr., and 0.9c. per kw.-hr. for all in excess of the last figure. It was his impression that the City of Milwaukee had a similar off-peak rate.

It will be remembered, in this connection, that at a preceding hearing John W. Lieb, of the New York Edison Co., made the statement that under the conditions existing in New York City there was no such thing as off-peak service, because a sudden demand might arise to tax the entire capacity of a station.

Mr. Moses was asked whether he could account for the paradoxical statement that in some plants less coal was burned for heating and generating current than for heating alone. He said that where live steam was used for heating it was quite probable that too high a temperature was remedied by opening windows; whereas, in a plant using exhaust steam for heating, the supply available is only that which comes through engines and pumps, at a fairly uniform rate, and therefore there is likely to be less waste of heat because of excessively high temperatures.

The hearing was adjourned until June 10, 1918.

Record Coal Production

A week's record production of bituminous coal is indicated by reports received by the United States Fuel Administration covering the week ended Apr. 27. During that week the total output is estimated by the United States Geological Survey at 11,803,000 net tons, an increase of 6.1 per cent. over the preceding week. The average production per working day was 1,946,000 net tons compared to 1,840,000 net tons the previous week and 1,680,000 net tons during April, 1917.

The output for the month of April, 1918, is estimated at 36,478,000 net tons, an increase of 10 per cent. over April, 1917. Production for the four months ended April, 1918, is estimated at 181,992,000 net tons, an increase over 5,000,000 net tons, or about 3 per cent. over the same four months of 1917. The week ended Apr. 27 recorded not only the highest rate of production for the past 12 months, but was the third successive week of rising production. The reports to the U. S. Geological Survey showed a gradual improvement in car service conditions at the mines during the week ending Apr. 20. Loss of production due to car shortage throughout the country was reported as 16.2 per cent. as against 18.1 per cent. for the preceding weeks. Loss due to labor shortage was 4.8 per cent. as against 2.6 per cent. during the preceding weeks.

There is quite a loss due to "no market" all through the Middle West, the loss running from 5.8 per cent. for the Rocky Mountain States to 30.7 per cent. for mines in Iowa.

During the week ended May 4 bituminous output declined slightly after three successive weeks of rising production, the total production being estimated at 11,559,000 net tons, a decrease of 2 per cent. from the week previous.

The continuous rotary motion of the turbine is ideal for certain drives, but the crank is still the ideal drive for an air compressor, as it gives the mechanical advantage of power application just when it is needed.—*Marine Engineering.*

Changes in Coal-Zoning Plan

Under an order modifying the zone system issued by the Fuel Administration, bituminous coal originating on the Broad Top Mountain railroads and their short-line connections, in the States of Pennsylvania, West Virginia and Maryland, when routed via the Pennsylvania R.R., is embargoed from Baltimore and Washington markets.

To meet this situation the Fuel Administration will arrange for the essential supply to the points designated from mines on the Baltimore & Ohio, the Western Maryland and their connections, which lines afford a much more direct route to these points. As a consequence a vast amount of time and mileage will be saved to the Pennsylvania lines, thus assuring an increased movement of coal to points in eastern Pennsylvania, New Jersey and New England.

Consumers of the classifications named in Preference List No. 1, of the priority board, will receive coal in preference to any other individual or class of consumers.

Under the modified order, which became effective on Apr. 20, producers in the sections named will be prohibited from selling, shipping or distributing coal to dealers and consumers at Washington and Baltimore and at all stations on the Baltimore & Sparrows Point R.R. when routed via the Pennsylvania.

The order forbids the shipment of bituminous coal over the railroads named for railroad delivery or transshipments to vessels in Baltimore, at President Street, Highlandtown, Jackson's Wharf, Calvert, Bolton, Frederick Road and Gwynns Run station; and points of delivery between any two of such stations; all stations and points of delivery on the Baltimore division of the Pennsylvania R.R. from Loudon Park, Md., to Catonsville, Md., inclusive, and Arbutus, Md., to Washington, D. C., and Rosslyn, Va., including Popes Creek branch, running from Bowie, Md., to Popes Creek, Md., inclusive.

Consumers located on the Pennsylvania and Baltimore & Sparrows Point railroads will continue to receive their coal at their regular points of delivery, the coal moving via the Baltimore & Ohio and Western Maryland being delivered to the Pennsylvania at junctions near destinations.

Navy Steam Engineering School

The United States Navy Department has perfected plans for the enrollment and training of considerable numbers of engineering officers. A school for this training known as the United States Navy Steam Engineering School, has been established at the Stevens Institute of Technology, Hoboken, N. J., under the guidance of Dean F. L. Pryor as Civilian Director.

The course consists of five months' training divided as follows: One month of military training at the Naval Training Camp, Pelham Bay Park, New York; one month at the U. S. Navy Steam Engineering School; two months' practical training on board ships and in repair shops in the vicinity of New York; one month finishing course at the U. S. Navy Steam Engineering School.

The school is open to men between 21 and 30, who are physically qualified, of thorough ability and officer-like character, and who have completed the engineering course at any recognized technical school.

This school presents particularly desirable opportunities to the young technical man, both in affording him a proper outlet for his trained facilities during the war and in rounding out his college work with a practical course and school experience which will be of value to any engineer.

The service that a graduate from the school will perform will be that of an engineer-officer in the auxiliary service of the Navy. A graduate of the school will be commissioned an ensign in the Naval Reserve Force.

Information has been sent to all registered technical schools and should be on file at the President's office. For any additional details application can be made to the Civilian Director, U. S. Navy Engineering School, Stevens Institute, Hoboken, N. J.

Any men, graduates or undergraduates, who are registered in the draft can enroll with the proper enrolling officer by securing from the draft board a letter of release, which in all probability can be obtained for this purpose, provided the men are not included in the current draft quota.

Special provision has been made for the continuance of the school with proper material by a Navy regulation which permits undergraduates of the freshman, sophomore and junior classes in recognized engineering schools to enroll in the Navy with a rating seaman second class and continue their courses at the institutions where they have matriculated. Such men will be called into active service after their graduation and can at that time, if they are physically qualified to pass an officer's physical examination, enroll for the course at the United States Navy Steam Engineering School.

Trained Engineers for Naval Service

The Bureau of Navigation, Navy Department, is desirous of securing trained engineers for general service in the Navy in steam and electrical engineering and radio duties.

Applicants will, if accepted, be enrolled as ensigns in the Naval Reserve Force and will be sent to the reserve officers' school at Annapolis for a special course of about four months, after which those who finish this course successfully will be placed in further training ashore or afloat, and then become available for regular sea or shore duty as the exigencies of the service may demand.

Applicants for this general service should have the following qualifications: A degree in mechanical, electrical or mining engineering, conferred by a college of recognized standing; at least two and one-half years' practical engineering experience subsequent to graduation (exclusive of time spent as sales agent); not over thirty-five years of age; physically strong and sound in health.

The American Institute of Electrical Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers, Naval Consulting Board and National Research Council have each been requested to submit a list of fifty names equally proportioned among personnel trained in steam-engineering duties, electrical-engineering duties and radio duties; but the exact engineering duties to be performed in general service by each applicant will be decided after completion of the training under Naval supervision.

It is probable that from among the applicants selected, a class will be formed at the Naval Academy about the middle of June. Each applicant should without delay forward to the Engineering Council, which is acting for the five organizations named, a résumé of his education and engineering experience, together with a small photograph, if practicable, and such letters of recommendation as it may be possible to submit, addressed to 29 West 39th St., New York City.

Government Wants Business Diplomats

The Government is looking for big-caliber men with foreign trade experience to serve as commercial attachés for the Bureau of Foreign and Domestic Commerce, Department of Commerce, and announces that appointees will be accredited to American embassies or legations abroad and will be expected to meet in a creditable manner the most important Government officials and business men in such countries and make trade reports. A rigid examination will be held on June 6, and those interested are urged to write at once to the Bureau of Foreign and Domestic Commerce, Washington, for further details.

The salary of the Commercial Attachés ranges from $4000 upward, and there are transportation and other allowances. The Department of Commerce is also planning to appoint trade commissioners to Europe, South Africa and the Far East in the near future.

Many engineers forget, or never knew, that in a non-reversing engine only one side of the crankpin gets any wear. Think this statement over, and you will find it true.—*Marine Engineering.*

Maximum Production with Minimum Waste

The United States Fuel Administration has announced the appointment of Thomas R. Brown, of Pittsburgh, as administrative engineer for the Pittsburgh district, and C. P. Billings as special staff assistant. These appointments were made as a preliminary step toward putting into operation a general plan for fuel conservation in power plants.

This plan is the result of conferences with the Federal Fuel Administrators and their committees for the group of states which together consume about 70 per cent. of all the coal used in the United States, exclusive of railroads. The plan has received the indorsement of the fuel administrators of all these states, as well as the approval of the United States Bureau of Mines and a committee representing the Engineering Council of the four national engineering societies.

The slogan of the campaign is "Maximum production with minimum waste." In other words, the object is to operate all industries at full capacity, but at the same time to make a pound of fuel perform its maximum service in power, light and heat.

In laying the foundations for the organization it has been anticipated that this work should become a permanent service of the Government.

Ten to twenty per cent.—that is, from 25 to 50 million tons of coal per year—can be saved by the correct operation of steam power plants, using their present equipment, in the industries, in office buildings, hotels, apartment houses, etc.

It is considered most important that all existing fuel-conservation committees, committees of chambers of commerce and national defense, manufacturers' associations, and other bodies be continued in full force, and that the work of such organizations be consolidated with the national program, which comprises certain fundamentals as follows:

FUNDAMENTALS OF THE PROGRAM

Personal inspection of every power plant in the country.

Classification and rating of every power plant, based on the thoroughness with which the owner of the plant conforms to recommendations.

Responsibility of rating the plants will fall upon an engineer in each district, the rating to be based on reports of inspectors, who will not express opinions, but will collect definite information. The State Fuel Administrator, in his judgment, may entirely or partially shut off the consumption of coal to any needlessly wasteful plant in his territory.

Inspectors are to be furnished from one or more of the following sources: Inspectors of the steam-boiler insurance companies; state factory inspectors; engineering students from technical colleges; volunteers.

The ratings will be based on recorded answers to questions, each of which will be given a value depending upon its relative importance to the other questions. Depending on the efficiency of methods in use in any plant, it may be rated in Class 1, 2, 3 or 4.

The ratings will be based on existing equipment. The difficulty, delay and expense involved in the installation at this time of improved power equipment is fully recognized, but experience has proved that 10 to 20 per cent. of fuel now used in power plants can be saved by improvements in operation alone.

In advance of the first inspection a questionnaire will be sent to every power plant in each district, with notice to the owner that within 60 or 90 days his plant will be inspected personally and the questionnaire will be checked up by the inspector upon his visit. This action will tend to prepare the minds of plant owners for what will follow. It will operate to induce proper care in furnishing information and will also tend to produce a desire to improve their plants, if necessary, so that they may be rated in a high class by the time the inspector calls.

It is recommended that a board of competent engineers be attached to the conservation committee in each state; also a corps of lecturers to arouse public interest and disseminate engineering information.

The Fuel Administration has prepared a 50-minute film of moving pictures showing good and bad operation in the steam-boiler plant, methods of testing boilers, fuels, etc. These pictures will be available for each state in connection with its educational propaganda.

The administration is also preparing a series of official bulletins on engineering phases of steam and fuel economies. Some of these are now ready for printing. They will include: Boiler and Furnace Testing; Flue Gas Analysis; Saving Steam in Heating Systems; Boiler-Room Accounting Systems; Saving Steam and Fuel in Industrial Plants; Burning Fine Sizes of Anthracite; Boiler Water Treatment; Oil Burning; Stoker Operation.

In addition to this service a list of competent engineers has been prepared in Washington for each state and is available for use of each local administration. As the work develops, still further constructive assistance is contemplated for helping owners to bring their plants up to a high plane of economic operation.

Opposing Hun Force with Engineering Intelligence

Preparations by American engineers for leadership in the coming industrial development of Russia are being urged by the Russian Society of Engineers of Chicago. This organization was formed to help introduce modern achievements of American engineering into Russia and to develop friendly relations between the two countries. These aims are of special importance at the present time, as Russia is beginning to emerge from its chaotic conditions and to show increased resistance to the German invaders. To strengthen this resistance means to keep the vast natural resources of Russia from falling into the hands of Germany. This as well as the great prospective market into which Russia will ultimately develop should interest the American business man and especially the engineer who is the modern industrial pioneer. To promote this work a series of lectures by Russian and American engineers on the industrial needs of Russia and the mutual benefits to be derived by commercial intercourse is being arranged for all Chicago engineers by the society.

With a spirit of coöperation in this international patriotic endeavor the Western Society of Engineers is in accord, and the first meeting will be held May 22 in its rooms. W. J. H. Strong, Strong Engineering Co., will talk on "Industrial Developments in America as Compared With Those in Russia," and W. W. DeBerard on "Engineering Publicity." The Young Men's Committee of the latter society has already begun to study international subjects intensively, having spent two nights on the "Situation in Colombia, South America," and one on "Russia."

It is certain that the American engineer's horizon will not be to the boundaries of the United States hereafter, and studies of foreign development problems must be undertaken if the engineer is to keep in the foreground of obvious opportunities.

Control Over Power Companies

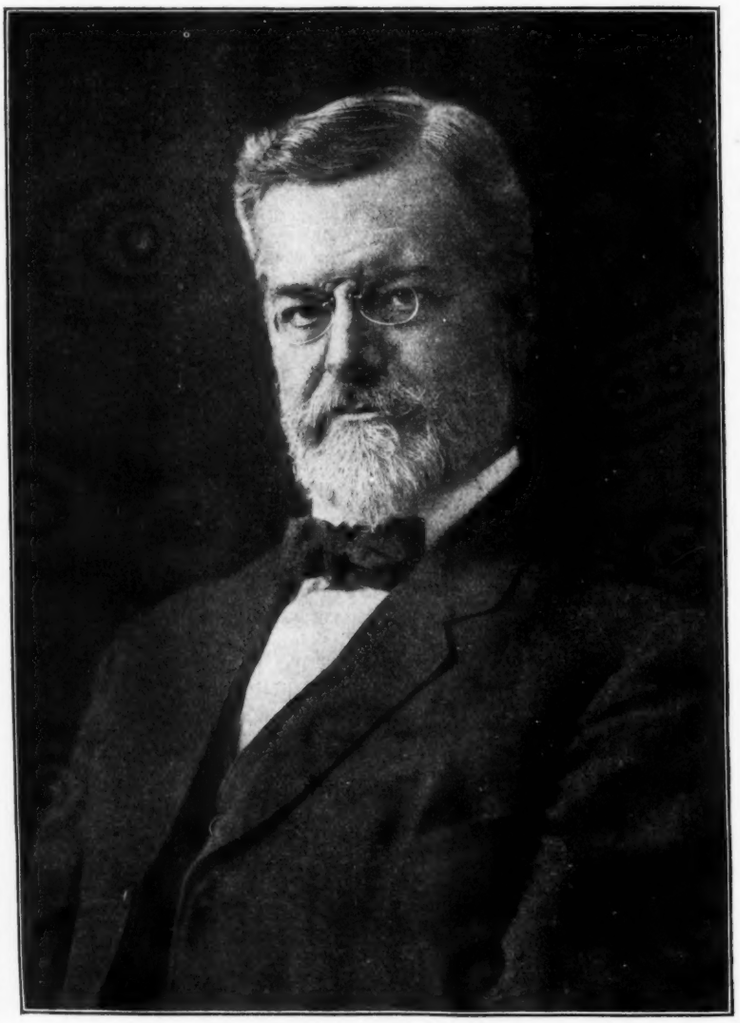
Upholding an order of the New York Public Service Commission, Second District, restraining the Oneonta Light and Power Co. from continuing to operate within certain territorial limits in Otsego County, N. Y., the Appellate Division of the New York Supreme Court holds that where an electric-power company's charter makes its right to exercise its powers within the limits of a town, village or city conditional upon obtaining the consent of the municipal authorities, there is no right to do business within such limits in the absence of such consent, although the owners of private property to be served consent to the stringing of poles, wires, etc., across their property. It is further decided in the same case that the fact that an electric-power company may acquire a private right-of-way for its transmission lines does not defeat supervisory control of the construction work by the Public Service Commission. (167 New York Supplement, 486.)

Frederick Remsen Hutton

IT IS with deep regret that we announce the death of Frederick Remsen Hutton, well-known engineer, educator, and distinguished member of the American Society of Mechanical Engineers, at his home, New York City, Tuesday, May 14. Death was due to heart trouble.

Professor Hutton was born in New York City, May 28, 1853; he died in his sixty-fifth year. After preparation in a private school, he entered Columbia University, receiving the degree of A. B. in 1873. After graduation he entered the School of Mines and was given its degree in 1876. Later he became an instructor, and was assistant to the late Professor Trowbridge, entering the faculty as adjunct professor in 1881 and professor in 1890. Professor Hutton served as head of the department of mechanical engineering until his resignation in July, 1907, when he was elected professor emeritus. From 1899 to 1905 he was Dean of the Schools of Engineering.

In 1911 he served as consulting engineer to the Department of Water, Gas and Electricity, New York City, and from 1905 to 1911 was vice chairman of the Museum of Safety. He was consulting engineer to the Automobile Club of America and chairman of its Technical Committee since 1912, in which capacity he supervised the important testing work conducted by the club in its laboratory.



FREDERICK REMSEN HUTTON

It is as a member of the American Society of Mechanical Engineers that Professor Hutton was most widely known. He was made president of that society as the culmination of twenty-four years of service as its secretary. He had the honor of presiding at the first meeting of engineers in the splendid auditorium of the Engineering Societies Building in 1907. He represented the American Society of Mechanical Engineers at the formal ceremonial days of the dedication of the new building, a noteworthy event in the annals of American engineering society history. It was in 1883 that Professor Hutton became secretary of the A. S. M. E., three years after its organization. The offices were then at 17 Cortlandt St., and more than once in those early days he paid the office rent out of his own pocket.

Professor Hutton was of great influence in giving international recognition to the society. He was connected with arrangements of the European trip in 1889, one of the noteworthy events in the society's history. He was a member of the Conference and Building Committee of the United Engineering Society which planned the present Engineering Societies Building at 29 West 39th St.; he also was one of the Board of Trustees holding the corporation for the United Engineering Society, 29 West 39th St., New York City.

Professor Hutton contributed much to scientific literature. His most important books are: "The Mechanical Engineering of Power Plants," "Heat and Heat Engines" and "The Gas Engine." The first is used as a textbook in some of the technical institutions of Japan. He contributed considerable to encyclopedias, dictionaries and the technical press. His speech at Washington before the American Uniform Boiler Code Congress early last year struck a new note in industrial-governmental relationship. Although an individualist by theory and preference, he recognized that the growing complexity of the social fabric would sooner or later compel significant changes in the relation of individuals, corporations and the state. At this congress he pointed out that a boiler explosion was a community loss, and not alone a loss to the purchaser, builder and insurance company.

He supplemented this speech with an article published in *Power* for June 5, 1917, p. 774, and in this he asked the significant question: "—— is there any logical pausing stage before the community demands economy and efficiency in the use of increasingly precious fuel in the generation and distribution of power, with a view to lowering the cost to the community of such commodities as call for power in their production?"

To quote further from this article: "First, every machine (and a power-house boiler and engine and generator are in this class) should be functioning continuously if possible, to earn the interest on its cost and pay the proper share of overhead charges. Second, an accident that involves the machine or disables its operator, or both machine and operator, breaks into this continuity of earning and involves losses. These losses fall into several groups: First, the cost of repair; second, the losses of idleness; third, the costs of compensation for bodily injuries, or of insurance against this cost; fourth, the costs in wasted stock and defective work, due to teaching a new operator, also in the slow and inferior production of the worker as yet inexpert; and fifth, the costs of the slackened speed of all workers in the department while the memory of it is fresh in the minds of those who witnessed the accident. There are, furthermore, indirect losses from the accident, which reach the community only through the heavy losses borne in the narrow circle affected when its wage-earner is disabled."

Among the societies and clubs to which Professor Hutton belonged are the Engineers' Club, New York, and the New York State Society of Cincinnati.

Final Figures for Rainbow Division

Final figures for the Rainbow Division given out by the Advisory Trades Committee of the Liberty Loan Committee, May 11, showed that the total subscriptions for all the 86 business and professional organizations comprising this division was $564,767,950. The grand total for the Second Loan was $409,367,150.

At the beginning of the Third Loan, an allotment of $450,000,000, one-half the total for the entire Second Federal Reserve District, was given the Rainbow Division. During the first two weeks of the campaign it looked as if the Division was falling behind the schedule laid out by the Central Committee. Emergency meetings were held and an intensified plan of action was begun.

One week after this, on Apr. 27, the total for the Second Loan was passed and on May 3 the figure aimed for, $450,000,000, was also passed.

Seventy committees reached and passed their total for the Second Loan. Of these the one that made the greatest percentage increase was the Electrical Committee. Its total for the Second Loan was $809,000 and for the Third, $9,457,000. This committee was awarded an Industrial Bull's-eye Honor Flag containing 21 stars, each star indicating an increase of 50 per cent. over the preceding total.

Standing out as one of the best things in the entire campaign was the splendid support of the workers. Not only did the employees buy in greater amounts and in larger numbers than in the two preceding loans, but the labor unions gave their fullest support and also bought more bonds than ever before.

How well the men and women workers supported the Third Loan can be seen by the fact that fully 5000 Industrial Honor Flags were awarded to firms where 60 per cent. and more of their employees bought the third issue of bonds. Nearly 1500 of these were 100 per cent. flags, meaning that every worker in each factory, firm and company bought a bond. It is expected that the total of 100 per cent. flag winners may reach and pass the 2000 mark when all the applications have been received and verified.

Personals

Frederick Ray, consulting engineer, announces the removal of his office from 95 Liberty St. to the Mills Building, 15 Broad St., New York City.

Cyrus Garnsey, Jr., has been appointed assistant fuel administrator. He will be in general charge of the administrative work of the Fuel Administration.

J. M. Riordan, until recently sales engineer of the Grant Lees Gear Co. of Cleveland, and formerly representing the Fellows Gear Shaper Co., of Springfield, Vt., in the Central States, is now connected with the sales organization of the Cleveland Milling Machine Co., 18,511 Euclid Ave., Cleveland, Ohio.

John A. Stevens and associated engineers, of Lowell, Mass., were presented the medal by the National Association of Cotton Manufacturers, at the Hotel Biltmore, New York, on May 3, for their paper on "The Evolution of the Steam Turbine in the Textile Industry," presented at the annual meeting of the association which was held in Boston, Apr. 25-26, 1917.

Engineering Affairs

The International Railway Fuel Association will hold its tenth annual convention at the Hotel Sherman, Chicago, May 23-24. Representatives of the United States Railroad Administration and the United States Fuel Administration will take a large part in the activities.

The New York Chapter of the American Association of Engineers will hold its annual election of officers at the Hotel McAlpin on May 22, at 8 p.m. G. A. Harris, chief engineer of the American Steel Export Co. will deliver an address on "The Opportunities for the American Engineer in the Export Field."

The Society for Electrical Development, Inc., held its annual meeting on Tuesday, May 14, at the offices of the society in New York. James R. Strong presided. The general manager read his annual report, reviewing the work of the society during the past year and suggesting activities for the coming year. At the Board of Directors' meeting which followed the annual meeting, it was decided to continue the work of the society for another year upon the present basis and to conduct a "Convenience Outlet" campaign as suggested by the general manager. An appropriation was made to carry on the campaign along national lines, similar to the "Wire Your Home" and "America's Electrical Christmas" campaigns. The officers elected for the ensuing year were: Henry L. Doherty, reëlected president; Joseph E. Montague, vice president and as a member of the executive committee; Gerard Swope, chairman of the executive committee; James M. Wakeman, reappointed general manager; James Smieton, Jr., secretary and treasurer.

Miscellaneous News

A High-Pressure Steam Pipe exploded in the testing room of the Sturtevant Blower Works at Hyde Park, Mass., on May 9, killing one man and injuring three others. The men were testing a turbine engine, forcing steam into it through a pipe 2½ in. in diameter, which broke, one section of it going through the wall of the building.

Business Items

The Brown Instrument Co., of Philadelphia, will open a new office at 2086 Railway Exchange Building, St. Louis, June 1, in charge of Paul H. Berggreen.

The Lehigh Foundry Co. and the Lehigh Car, Wheel and Axle Works, of Fullerton, Penn., have been merged into one organization to be known as the Fuller-Lehigh Co., with office and works at Fullerton. The properties of the two companies are adjoining and have been under the same management for a number of years. The change therefore is one of name only, the executive personnel remaining the same. J. W. Fuller is president.

The Joseph Dixon Crucible Co. at its annual and regular meetings on Apr. 15 elected the following directors and officers: Directors: George T. Smith, George E. Long, William G. Bumsted, Edward L. Young, J. H. Schermerhorn, Harry Dailey, Robert N. Jennings. Officers: George T. Smith, president, George E. Long, vice president, J. H. Schermerhorn, vice president, Harry Dailey, secretary, William Koester, treasurer, Albert Norris, assistant secretary and assistant treasurer. The American Graphite Co., Inc., is a subsidiary of the Joseph Dixon Crucible Co. and on the same day elected the following officers: George T. Smith, president, George E. Long, vice president, J. H. Schermerhorn, treasurer, Harry Dailey, secretary. The directorate is the same as that of the Joseph Dixon Crucible Co.

NEW CONSTRUCTION

Proposed Work

N. H., Manchester—The Manchester Traction Light and Power Co. is receiving bids for the erection of a 25 x 45 ft. addition to its power house. F. W. Gray, Elm St., Arch. Noted May 14.

Mass., Boston—The Board of Education will receive bids until May 24 for the installation of a heating system in 2 schools. About $10,000.

Mass., Canton—The Springdale Finishing Co., Pine St., will build a 2 story, 45 x 50 ft. reinforced concrete, steel and brick power house. Estimated cost, $25,000. Noted Apr. 30.

Mass., Dedham—The Cochrane Manufacturing Co., 56 Barrett Ave., Malden, will soon receive bids for the erection of a power house, transmission line and dam here. E. Worthington, Engr.

N. Y., Buffalo—The Buffalo Cereal Co., Chamber of Commerce, is having plans prepared for the erection of a 40 x 40 ft. power house in connection with its new plant.

N. Y., Buffalo—The Lamoka Electric Water Power Corporation has been given a franchise by the State, permitting it to use the waters of Little and Lamoka Lakes to generate electric power.

N. Y., New York—The B. L. M. Bates Corporation, Hotel Belmont, is in the market for boilers and superheaters. Estimated cost between $66,000 and $70,000. Warren & Wetmore, 16 East 37th St., Arch.

N. Y., New York—The United Electric Light and Power Co., 130 East 15th St., has purchased a site and plans to build an electric power station. J. G. Swallow, Supt.

N. Y., Olean—The Olean Electric Light and Power Co. plans to purchase additional equipment. F. G. Tennant, Gen. Supt.

N. Y., Schenectady—The American Locomotive Co., North Jay St., is having plans prepared for the erection of a 120 x 175 ft. addition to its boiler house.

N. Y., Syracuse—The Syracuse Lighting Co. is having plans prepared for the erection of an electric lighting plant on South Warren St.

N. J., Bayonne—The Elco Works, Ave. A and North St., plans to build a new power plant and install equipment including 2 direct connected engines, 400 hp. each; direct current generators, 250 kw., 25 volts with four 250 hp. boilers, etc.

N. J., Mays Landing—The Bethlehem Loading Co. will build a power plant near the South River in connection with its plant. C. J. Sittinger, Power Engr.

N. J., Ogdensburg—The New Jersey Zinc Co. plans to build a 1 story power house here. Estimated cost, $15,000. A. Lee, 55 Wall St., New York City, Purchasing Agent.

N. J., South Plainfield—The Spicer Manufacturing Co. has plans under consideration for the erection of a new power house in connection with its plant.

Penn., Bethlehem—The Bethlehem Electric Co. plans to issue $50,000 bonds; the proceeds will be used to build additions and make improvements.

Penn., Elwood City—The Pennsylvania Power Co. has purchased a 5 mile site on the water front in the Turkey Hill section, and plans to build a dam. L. B. Round, Supt.

Penn., Philadelphia—J. Bromley & Sons has awarded the contract for the erection of additions and improvements to its boiler plant at Front and Dauphin St., to G. W. Stewart & Co., 2123 Germantown Ave.

Penn., Philadelphia—City will soon award the contract for improvements to its power plant. W. H. Wilson, Director of Public Safety.

Penn., Pittsburgh—The Pittsburgh Modern Laundry Co. is having plans prepared for the erection of a new power plant in connection with its proposed plant. Estimated cost, $60,000. P. W. Irwin, Renshaws Bldg., Arch.

Penn., Wescoesville—The Commissioners of Lehigh County are considering the erection of a boiler plant. T. Moyer, 824 Hamilton St., Allentown, Arch.

N. C., Gibsonville—The Gibsonville Milling Co. plans to build an electric power system from here to Summers Mill.

N. C., Glide—R. O. Blanchard is in the market for electrical and water power machinery.

La., Ville Platte—The Town will receive bids until June 4, for the erection of an addition to its electric lighting plant and line. Estimated cost, $5000. Work will include the installation of a 35 kw. alternator, setting 1 motor driven pump, switchboard, series lighting transformer and regulator, moving and repairing 1 Mietz and 1 Weiss engine and General Electric generator. Address A. C. Jones, Opelousas, La.

Tenn., Rutherford—City voted to issue $10,000 bonds for the installation of an electric lighting plant.

Ohio, Cincinnati—The Union Gas and Electric Co. plans to install a third generating unit.

Ohio, Marion—The Delaware and Marion Ry. Co. has geen granted a franchise by Marion Co. Commissioners, to erect a 10-mile transmission line from here to Caledonia.

Ohio, Youngstown—The Hydraulic Gas Power Co. has increased its capital stock from $200,000 to $300,000; the proceeds will be used to build additions to its plant.

Ill., Chicago—C. A. Brown, c/o C. E. Frazier, 30 North Darborn St., is in the market for a low pressure steam heating plant for its truck body factory on 35th and Shields Sts.

..Ill., Chicago—The Chicago United Theaters Incorporated, c/o W. W. Alschuler, Arch., 111 West Washington St., plans to install a low pressure steam plant in its 2 story, 136 x 150 ft. theater on 63rd and Union Sts.

Wis., Milwaukee—City is in the market for one 125 brake hp. alternate current motor and one 20 in. centrifugal pump. Estimated cost, $2000.

Minn., Caledonia—The Root River Power and Light Co., Preston, plans to extend its electric system from here to Houston. A. H. Hanning, Preston, Mgr.

Kan., Baxter Springs—E. D. Nix, L. D. Knight and C. M. Mitchell, mine owners, plan to install equipment in their zinc mine. The installation includes engines, boilers, etc. C. M. Mitchell, Supt.

Kan., Wichita—The St. Francis Hospital is having plans prepared by E. Forsblom, Arch., 403 Winne Bldg., for the erection of a 2 story, 49 x 68 ft. power house and laundry. Estimated cost, $20,000.

Mont., Scoby—School District No. 1 will receive bids about June 15, for the installation of a heating plant here. Estimated cost, $15,000.

Mo., Seneca—The Oklamo Mining Co. plans to install engines, boilers, etc., in its lead mine. C. B. Bettis, Joplin, Pres. C. T. Jobes, Supt.

Ark., Lamar—The Peoples Service Co., 312 Barnes Bldg., Muskogee, Okla., has secured a franchise to establish an electric lighting plant here.

Tex., Del Rio—City plans to install an electric lighting plant.

Okla., Jennings—City voted to issue $25,000 bonds for the installation of an electric lighting plant. Noted May 14.

Okla., Miami—City plans to build a power and water plant. Estimated cost, $250,000. Bids are now being received for the new equipment for same.

N. M., Portales—City plans an election soon to vote on $20,000 bonds for the erection of an electric light and power plant. W. H. Braley, Clerk.

Ariz., Nogales—The Arizona Gas and Electric Co. has petitioned the State Corporation Commission for authority to issue $100,000 bonds; the proceeds will be used for the installation of an additional generating unit, etc.

Ore., Klamath—The Pacific Gas and Electric Co., 445 Sutter St., San Francisco, Calif., the Northern California Power Co. and the California Oregon Power Co. plan to build a 300 mi. transmission line from the Klamath River plant of the California Oregon Power Co. to San Francisco bay district. This work and many other improvements will cost about $1,000,000.

Ont., Bridgeburg—The Board of Education plans to install a heating system in the Phipp Street school. An appropriation for $10,000 is before the aldermanic board for same.

Sask., Regina—A. Beach, City Clerk, is in the market for electrical equipment for lighting. About $200,000 will be expended.

CONTRACTS AWARDED

R. I., Pawtucket—F. W. Taylor, 438 Main St., has awarded the contract for the erection of a 1 story, 65 x 80 ft. boiler house in the rear of Oak Hall Bldg., to J. W. Bishop Co., Butler Ex.; 4 new boilers will be installed.

N. Y., Albion—The Western House of Refuge has awarded the contract for the erection of an addition to its boiler plant, to H. C. Belson, Albion.

N. Y., Brooklyn—The Arabol Manufacturing Co., 100 William St., New York City, has awarded the contract for the erection of an addition to its boiler plant, to J. H. Deeves & Bro., 103 Park Ave., New York City. Noted Mar. 19.

N. Y., Brooklyn—The Brooklyn Gas Co., 176 Remsen St., has awarded the contract for the erection of a 30 x 40 ft. addition to its boiler plant, to J. H. Deeves & Bro., 103 Park Ave., New York City.

N. Y., Brooklyn—The Flatbush Gas Co., Clarkson St. and Kingston Ave., has awarded the contract for a 1 story, 30 x 40 addition to its boiler house, to J. H. Deeves & Bro., 103 Park Ave., New York City.

N. Y., New York—The Interborough Rapid Transit Co., 120 Bway., is building a transformer station on East 57th St. Estimated cost, $45,000.

Penn., Philadelphia—The Germantown Steam Heating Co., has awarded the contract for alterations and additions to its power house on Pelham Rd. and Hortter St., to W. O. Springer, 349 West Hortter St.

Penn., Philadelphia—The Philadelphia and Reading R.R., Reading Terminal, has awarded the contract for the erection of a 1 story, 44 x 78 ft., brick, concrete and steel power house at Tulip and Somerset St., to Pringle Borthwick, 8018 Germantown Ave. Estimated cost, $30,000. Noted Nov. 27.

Md., Baltimore—Roberts Bros., Wolfe and Preston St., has awarded the contract for the erection of a cannery, to P. J. Cushen, 117 St. Paul St. Estimated cost, $13,065. The work includes the construction of a boiler house, warehouse, etc.

Ohio, Akron—The Wellman Seaver Morgan Co., 260 Kenmore Blvd., has awarded the contract for the erection of a power house, to the G. A. Fuller Co. Estimated cost, $30,000.

Ohio, Columbus—The U. S. Government has warded the contract for the erection of the Columbus Quartermaster Interior Depot, to Hunkin Conkey Co., 321 Cuyahoga Bldg., Cleveland. The work includes the erection of an electric light and power plant, etc.

Ill., Chicago—P. J. Hursen, 4446 West Madison St., has awarded the contract for the erection of an undertaking establishment to McCarty Bros., 10 South La Salle St. A new steam heating plant will be installed.

Ill., Chicago—The Illinois Central R.R. has awarded the contract for the erection of a new electric power plant at 98th St. and Cottage Grove Ave., to J. E. Nelson & Sons, 118 La Salle St. Estimated cost, $60,000.

Neb., Falls City—City let contract building 1 story, 50 x 110 ft. power house, to Bohrer Bros., Falls City. Noted Feb. 8.

Que., Drummondville—The Southern Canada Power Co., on St. Francis River, has awarded the contract for the erection of a power house and dam, to Morrow & Beatty, Ltd., Peterboro. Work includes the erection of an 80-mile transmission line.

..IE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Current	Individual Current
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	.....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* are as follows:

ANTHRACITE

	Circular Current	Individual Current
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	4.80@5.50
Barley	3.40@3.65	3.80@4.50
Rice	3.90@4.10	3.00@4.00
Boiler	3.65@3.90	.....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The rat e to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Current	One Yr. Ago	Current	One Yr. Ago
Pea	$3.45	$3.00	$4.35	$3.90
Barley	2.15	1.50	2.40	1.75
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.00	3.65	3.00
Boiler	2.45	1.80	3.55	2.90

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Mt. Olive & Staunton	Standard
6-in. lump	$2.65-3.00	$2.65-2.80	$2.65-2.80
2-in. lump	2.65-3.00	2.65-2.80	2.25-2.50
Steam egg	2.65-2.80	2.35-2.50	2.25-2.40
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut	2.65-3.00	2.65-2.80	2.65-2.80
2-in. screen	2.15-2.40	2.15-2.40	2.15-2.40
No. 5 washed	2.15-2.50	2.15-2.35	2.15-2.35

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.